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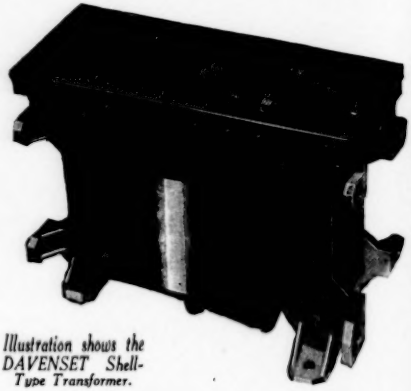

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THE

WIRELESS ENGINEER

AND

EXPERIMENTAL WIRELESS

VOL. X. MAY, 1933. No. 116

Editorial

Interference with Broadcast Reception

THE reception of broadcast programmes is subject to three classes of interference, viz., that caused by broadcast and other transmitters working on neighbouring wave-lengths, that due to natural electric phenomena, such as lightning, and that due to what the Americans call "man-made static." With the improvements in the design of receivers and the gradual elimination—one sometimes has cause to wish that it could be hurried—of spark transmitters, the first type of interference is well under control. The second type is of minor importance compared with the third, at least so far as the vast majority of people in this country are concerned. We have yet to hear of a case where a high class receiver is rendered permanently useless owing to atmospheric disturbance, whereas there are thousands of cases in which electrical disturbance due to trams, lifts, medical apparatus, etc., etc., defeats all attempts to receive a distant programme with good quality. The problem is a very complex one both technically and legally. The causes of disturbance are legion and in many cases the elimination of the disturbance would involve considerable expense, but this is no reason why the problem should not be seriously taken in hand. Surely it should be made an offence to offer for sale any apparatus which cannot be operated without causing a nuisance to one's neighbours, and it should also be made an offence to operate any such apparatus. Until some such step is taken the makers of electrical apparatus can hardly be expected to go to the trouble and expense of so perfecting their products as to make them non-disturbing. In many cases the cure would be simple and cheap, in others it would call for research, but wireless reception is like a new sense which mankind has developed, and just as one is not allowed to emit sounds and smells to the annoyance of his neighbours, so one should not be allowed to emit electric disturbances.

According to the E.T.Z. of 16th March, the Roumanian Government has promulgated a law dealing with the subject. It is divided into five articles, the first of which declares the right of the owner of a receiving apparatus to be able to use it without interference from other electrical apparatus. The second article declares it to be the duty of owners of electrical apparatus to introduce such modifications as may be necessary to prevent interference. The third declares

the right of the owner of receiving apparatus which is affected by interference to demand cessation of the interference and the payment of compensation. The fourth article deals with the punishment of those who do not comply with the regulations, whilst the fifth is concerned with the legal procedure. Such legislation in this country would probably lead to a great deal of controversy and litigation, but a move in this direction will have to be made sooner or later, as otherwise the increasing use of electrical apparatus will only intensify the interference. Two congresses have been held in Paris under the title " Congrès de Défense contre les Perturbations radio électriques " to discuss the problem from all points of view, and the Laboratoire Central d'Electricité has reported on experiments made with the object of exploring the methods available for rendering electrical apparatus innocuous. The subject has been discussed at the meetings of the International Broadcasting Union, and M. Braillard, the President of the Technical Committee, raised the matter at the recent Madrid Conference on radio-telegraphy. In this country there does not appear to have been any organised effort to deal with the problem, and we fear that nothing will be done until those bodies which are most closely concerned with broadcasting take action.

The Causes of Interference

One of the disturbers of the peace which is spreading at a rapid rate is the neon lamp sign ; the disturbance which is radiated from the lamp itself can probably be eliminated by surrounding it with an earthed metallic netting, but that which is transmitted along the wires must not only be prevented from radiating from the wires but also from passing through the transformer to the low tension network. Among the worst offenders is electromedical apparatus, which often makes wireless reception in its neighbourhood quite impossible. Much research has been carried out to see in what way electric tramways can be modified to reduce the disturbance caused, and the results have been surprising, as they have shown that the disturbance is not due so much to the making and breaking of large currents as to the small currents taken by the auxiliary apparatus when the cars are coasting. By keeping this current above a certain limit, using improved collecting bows, screening the signalling wiring and connecting condensers between the collectors and the car frames, the interference can be greatly reduced. Electric lifts, like many other electric appliances, can easily be made non-interfering by the introduction of suitable filters to the motors and to the controlling and signalling circuits.

Unfortunately the problem is complicated by the continual development of both wireless and industrial applications of electricity. As an example of the former we might refer to the ignition of motor car engines, which causes no appreciable interference with medium or long wave reception, but which is very troublesome on wave lengths of a few metres which are now being experimented with in the hope that they will prove eminently suitable for short range broadcasting and television. Fortunately it has been shown that this trouble can easily be eliminated by fitting resistances in series with the sparking plugs, if the day arrives when the motorist is compelled by law to cease emitting electromagnetic waves.

As an example of the new industrial developments which cause interference we have already mentioned the rapid development of the neon lamp ; another offender, and a very vicious one, is the ignition device fitted to automatic oil fired boilers for central heating systems. In all these cases steps should be taken to ensure that the makers and installers leave no stone unturned in their effort to be able to guarantee that the apparatus causes no appreciable interference to broadcast receivers in the neighbourhood, nor to any person taking a supply from the mains for any purpose whatever.

G. W. O. H.

The Simplification of Accurate Measurement of Radio-frequency*

By W. H. F. Griffiths, F.Inst.P., A.M.I.E.E.

In this article the successive stages of improvement which have been effected in resonant circuit wavemeters are briefly sketched, showing how, in the earlier days, the accuracy was at first limited by sensitiveness of resonance detection and, later, as improved methods of detection were introduced, by the instability of the coil and condenser units of the circuits themselves. For a number of years wavemeter improvement then centred round the improvement of condenser and inductance design with a view to increasing permanence—these resonant circuit components were of recent years so highly developed that their stability and permanence were masked, eventually, by greater uncertainties due to the available methods of resonance detection. And so, finally, the ultimate improvement is inevitable—the stable oscillating wavemeter working on the dynatron principle is developed. An extraordinarily accurate and stable design of such a wavemeter is described. Curves are given showing the variation of frequency with valve supply voltage to be in accordance with that anticipated on most of the ranges. An accuracy of 1 part in 20,000 is claimed together with a stability better than 1 part in 10^5. The calibration, moreover, is completely independent of valve replacement.

The range of the wavemeter described is 150–10,000 metres, but a wavemeter of similar accuracy and stability may be constructed with a range extended down to 30 metres.

TWENTY years ago laboratory wavemeters were calibrated by calculating the wavelength corresponding to various variable condenser settings from values of the inductance and the capacities measured by audio-frequency methods. In 1912 Prof. G. W. O. Howe read a paper before the Physical Society of London†, in which he described an original method of determining the self-capacities of the inductances of a standard wavemeter in order to arrive at a more exact figure for the effective capacity of the whole of its resonant circuit. Great inaccuracies had, of course, been introduced by neglecting to take account of this capacity augmentation by the range coils especially in wavemeters in which a considerable wavelength range was covered by a single sweep of their variable condensers. In the case considered by Prof. Howe in the paper referred to, a calibration error of over 10 per cent. was introduced by neglecting the effect of self-capacity of a wavemeter coil, whereas by allowing for it " in the way indicated (in the paper) the error can easily be reduced to *less than 1 per cent.*" The italics have been introduced by the present author in order to emphasise the inaccuracy which then existed even in laboratory wavemeters calibrated with this refinement. Quite ordinary commercial heterodyne wavemeters of to-day have an accuracy of this order and our modern ultimate standards of wavelength have a degree of accuracy at least a thousand times greater. The wavemeters of this period depended, of course, upon the natural wavelengths of simple resonant circuits—various methods being employed to detect their resonance with the frequency of the supply. Most of these methods made use of thermal indicators heated by the resonance current, among the earliest (round about 1903) being the heating of a fine platinum coil coupled to the main circuit inductance and included in the bulb of an air thermometer ‡.

Later, the use of vacuum thermo junctions in conjunction with sensitive moving coil galvanometers gave greater accuracy of resonance detection, so much so, in fact, that the stability of value of the inductance and capacity components of the resonant circuit became the limiting factors of accuracy. Even more sensitive detection of resonance was available in the form of aperiodically coupled crystal detector circuits in which

* MS. received by the Editor, Aug., 1932.

† " The Calibration of Wavemeters for Radio-Telegraphy." *Proc. Physical Soc.*, Vol. XXIV, Part V, Aug. 15, 1912.

‡ J. Dönitz, *Elektrotechnische Zeitschrift*, 1903, Vol. 24, No. 5.

were included sensitive direct current galvanometers.

This type of wavemeter was the only *standard* available in 1922 when the late Dr. D. W. Dye, of the N.P.L., designed Canada's National Standard Wavemeter.* This wavemeter, which may be taken as the best of its day, consisted of a number of range coils which were interchangeably connected to either of two massive variable condensers and resonance was detected by a number of vacuum thermo couples having heater resistances of various values appropriate to the circuit resistances of the ranges in which they were employed.

The coils were wound on pure ebonite formers and were in consequence very unstable and lacked calibration permanence although they were, naturally, of the best design available ten years ago. The variable condensers were of quite ordinary design although the workmanship of their construction was good. Their minima were set up to at least 200 $\mu\mu$F on the short wavelengths and 2,000 $\mu\mu$F on the long-wavelengths, but by quite ordinary *mica dielectric* fixed condensers.† The accuracy was a little better than 1 part in 1,000 over its entire range of 40–27,000 metres.

Such was the best standard available in the earliest years of broadcasting in North America—a standard which was ordered expressly for *keeping the closest possible checks on the wavelengths of transmitting stations with a view to minimising interference.*

The Development of Harmonic Wavemeters

Shortly after this, in 1923, the ætherial congestion increased with such rapidity that the simple resonant circuit type of wavemeter was insufficiently accurate and was discarded. An accuracy of one part in 1,000 over an extensive range of wavelength was inadequate with the advent of broadcasting in Europe and wavemeters whose frequencies were functions of values of inductance and capacity had to be replaced by others in which a single frequency only was employed and that governed synchronously by a valve maintained tuning fork or an oscillating piezo-electric quartz crystal. Energies were concentrated on perfecting these harmonic wavemeters with a result that accuracies of 1 part in 100,000 were soon aimed at and often attained [accuracies which have now been increased to the order of 1 part in 10^6]. The newly invented Elinvar steel having sensibly zero temperature coefficient of both linear expansion and Modulus of Elasticity was pressed into service by Dye in the construction of a standard tuning fork as a really stable standardised source of audio-frequency with which to govern the fundamental frequency of an Abraham-Bloch *multivibrateur*—a generator of periodic discontinuous current from which unlimited exact multiple frequencies can be obtained.

With such a standard available it was not surprising to find that attention was for a time diverted from the still further improvement of wavemeters, the frequency of which depended upon values of inductance and capacity, more especially as much energy was concentrated on the piezo-electric quartz crystal as a frequency standard for the control of a harmonic rich multivibrator system similar to that employed with the tuning fork. The Lucas-Sullivan crystal controlled multivibrator‡ was developed as a result of this work and has an accuracy, stability and degree of permanence decidedly better than that of the fork,

One or other of these single frequency control *harmonic* wavemeters is, of course, indispensable where the greatest accuracy is required—as a standard in fact. In both wavemeters a suitable harmonic of a multivibrator is selected by a previously calibrated tuned system. In order that it may be very accurately compared against the frequency being measured, this selected harmonic is modulated by an audio-frequency, usually of 1 kilohertz, which is produced either by the master frequency standard itself or by another generator held in harmonic or subharmonic synchronism by such standard. Interference beating occurs between this modulation note and the beat note caused by the heterodyning of its carrier frequency

* A tuning fork controlled harmonic wavemeter has just been set up in Ottawa to replace the older equipment.

† Three years later these mica condensers, having proved unstable, were replaced by others of air dielectric, a practice which, in recent years, is invariably resorted to.

‡ H. J. Lucas, *Journ. I.E.E.*, Vol. 68, No. 403, July, 1930.

(the selected harmonic) and the frequency being measured. The complexity of superimposed heterodyne and interferene beating together with the attendant slow synchronisation beating is such that operators have to be specially trained in order that they may interpret with certainty the sounds heard.

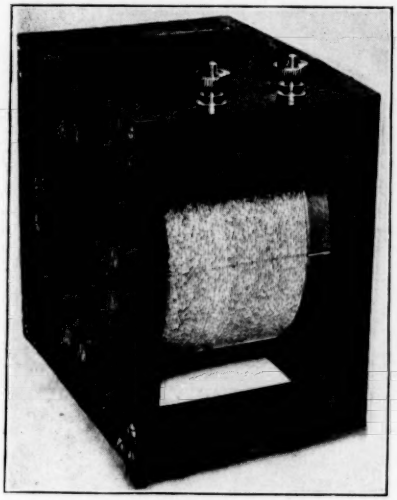


Fig. 1.—*Sullivan-Griffiths thermal compensated inductance; single layer type.*

The need for a *simple* resonant circuit wavemeter having an accuracy high enough for most laboratory work of precision and for checking the frequency of transmitting stations, and which, moreover, was continuously variable in frequency throughout its entire range and simple to operate, led the author to concentrate upon the design of fixed inductances and variable air condensers of much greater permanence and stability than had been available hitherto. The now well-known Sullivan-Griffiths thermal compensated inductance standards and the Sullivan-Griffiths series-gap variable air condensers were the results of this work. Associated in a resonant circuit they formed a very permanent and continuously variable standard of frequency and thus completed another stage in the development of the resonant circuit wavemeter, for the circuit accuracy, permanence and stability were now masked by the greater uncertainties of calibration due to the method by which its resonant frequency was detected—an aperiodically coupled crystal detector and galvanometer circuit.

A Variable Frequency Resonant Circuit of Great Stability and Calibration Permanence

The formers of the range coils of this resonant circuit were constructed on the principle of thermal expansion compensation which was described by the present author in the October 1929 issue of this journal. It was claimed that the method of former construction adopted reduced the temperature-coefficient of inductance to a negligibly small value and that the degree of stability would, in consequence of this, be greatly improved. That the claim was justified is shown by National Physical Laboratory Reports on six inductances constructed on this principle. Three of the coils tested were of the single layer type, Fig. 1, and three of the air-spaced multilayer type, Fig. 2, and it will be seen from tabulation I

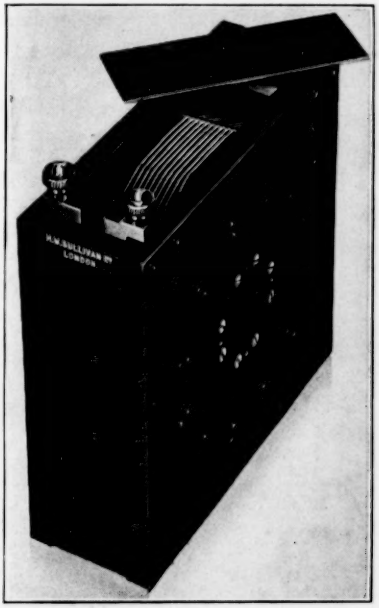


Fig. 2.—*Sullivan-Griffiths thermal compensated inductance; multi-layer type.*

that the principle is equally effective in either type.

TABULATION I.

Type of Coil.	L (μH)	Mean Diameter of Helix (cms).	Temperature-coefficient of L per degree Cent.
Single layer	50	6	None detected within the sensitivity of measurement.
,,	200	15	+ 0.00045%
,,	1,000	15	+ 0.0007%
Multi-layered	5,000	13	$< \pm$ 0.00018%
,,	20,000	13	$< \pm$ 0.00045%
,,	100,000	13	+ 0.00055%

That the compensation is complete may be judged from the fact that the temperature-coefficients of the coils are in every case much lower than the temperature-coefficients of *linear* expansion of any of the materials employed in their construction, viz. :—

Copper 0.0017% per degree Cent.
Keramot 0.007% ,, ,, ,,
Bakelite 0.0025% ,, ,, ,,

The freedom from temperature-coefficient is, of course, not the most important feature of these coils—their increased stability of value throughout long periods consequent upon this reduction of temperature-coefficient is of far greater importance for a range coil of an oscillatory circuit, in which a high degree of calibration permanence is required.

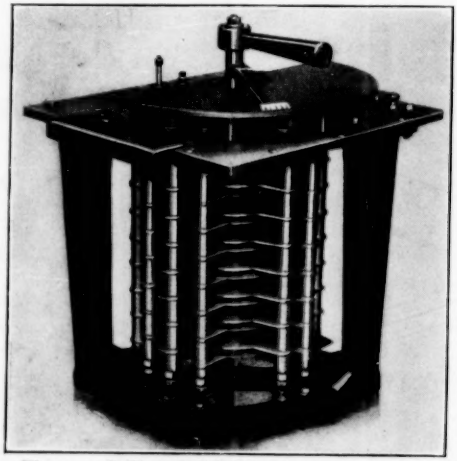


Fig. 3.—*Sullivan-Griffiths series-complementary dielectric gap variable condenser.*

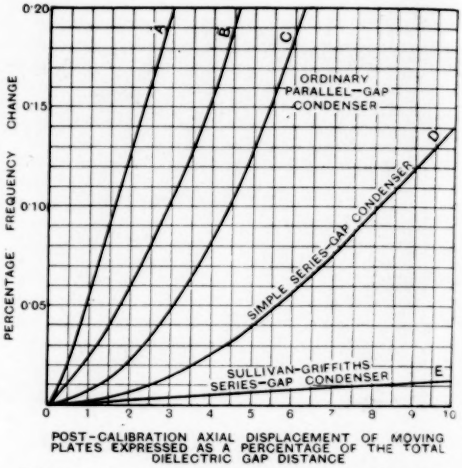


Fig. 4.—*Increased accuracy of a wavemeter due to the use of a series-gap variable condenser.*

It is only fair to state that measurements, such as those tabulated above, that are made at telephonic frequencies only show that the dimensional changes in the coils compensate in accordance with theory and that the actual *inductance* does not change with temperature. In coils for use in this wavemeter, however, changes of self-capacity with variations of both temperature and humidity of atmosphere are also of importance. On the single layer coils the self-capacities were of a very low order, from 2 $\mu\mu$F to 6 $\mu\mu$F, and their effect upon the temperature-coefficient of a total circuit capacity of not less than 500 $\mu\mu$F is inappreciable. The insulating covering of adjacent turns was not allowed to touch, the field between turns having to pass through air or Keramot, the permitivity of the latter material being unaffected by slight humidity. The multi-layered coils were of much larger self-capacity, 10–17 $\mu\mu$F, but here again the layers, as well as turns, were air spaced and only a minimum of solid insulating material actually bridged them at a few points of their circumferences. Experimental proof of the constancy of self-capacity of these higher value inductances was given in the article referred to above.

The variable air condenser was of the patented construction described in previous articles by the present author in this journal* and illustrated in Fig. 3, in which, in order to eliminate capacity variation (at any given scale setting) with dielectric gap changes, the series dielectric gap principle is employed. By arranging adjacent dielectric air gaps to be in series (electrically) and complementary *in reactance*, all calibration variations which would otherwise occur with post-calibration relative axial displacement and tilting of the moving and fixed plate systems are eliminated almost entirely. Thus a variable condenser of *wide range* is obtained with calibration stability and permanence equal to that of the best fixed air condenser standards. The curves of Figs. 4 and 5, show the important differences between variable condensers constructed on this and the ordinary parallel dielectric gap principle.

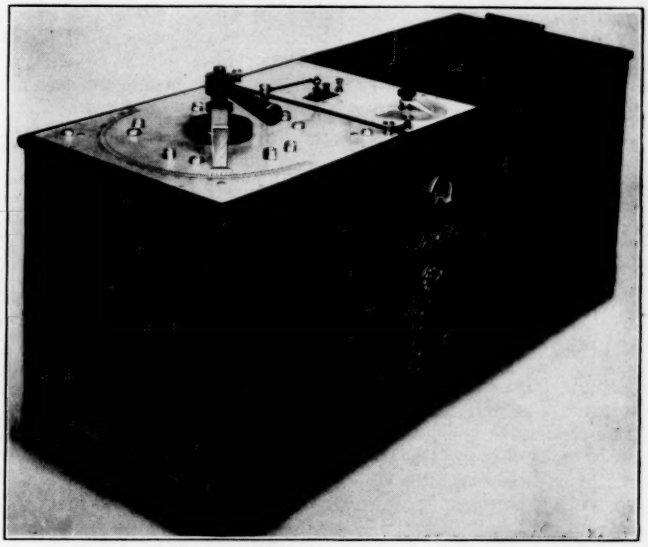


Fig. 6.—*Sullivan-Griffiths dynatron oscillating wavemeter.*

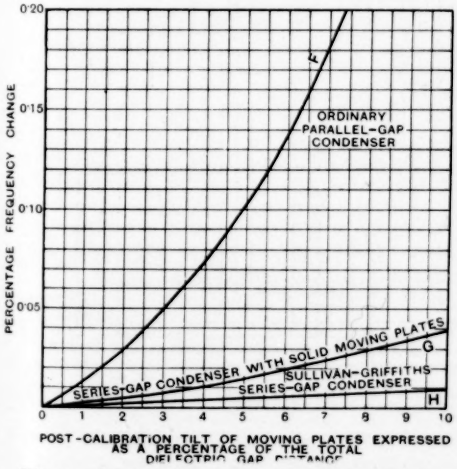


Fig. 5.—*Increased accuracy of a wavemeter due to the use of a series-gap variable condenser.*

The condenser had a capacity range of 550–1,000 $\mu\mu$F and its range was extended by a good quality fixed air condenser to 1,400 $\mu\mu$F. Ten range coils were associated with this condenser—seven of the single layer type and three of the multi-layer design.

The calibration permanence of these circuits was of the order 0.005 per cent. to 0.01 per cent. and stability over considerable periods better than 0.001 per cent., whereas their resonant frequencies could only be detected to about 0.01 per cent. to 0.02 per cent. with certainty.

Uncertainties of this latter order are introduced by a slightly variable mutual inductance between resonant circuit and detector circuit and by changes of detector resistance as well as by changes of capacity between the high potential system of the resonant circuit and the earthy detector circuit or inducing generator if the latter is insufficiently powerful. The proximity of the inducing coil of the generator is always a source of inconstancy of which the calibration does not take account. It is worthy of mention here that the resonant circuit of a wavemeter constructed on these lines for

* Vol. V, pp. 17–24, 63–74 and 278–279, 1928. Vol. VI, pp. 23–30, and 77–80, 1929.

a British Government Department in 1929 has maintained its original calibration to an accuracy of 1 part in 20,000 until the present time.

The Development of a Simple Dynatron Oscillating Wavemeter

With a view to removing these limitations to accuracy and in order to remove the necessity for an auxiliary generator of considerable power, the author has developed a simple generating wavemeter using the dynatron or negative resistance principle in which the minimum possible frequency modification of the $\frac{1}{2\pi\sqrt{LC}}$ value of the resonant circuit is introduced by the valve circuit associated with it as a negative resistance device. The circuit used is, in principle, that of the ordinary dynatron oscillator due to Hull*, which has been discussed in this journal recently by Colebrook† and McLachlan.‡ There is no need to explain its operation again, but it is thought that the methods of selection of a suitable valve such that spares may be selected which will have no effect upon calibration, and the rather special methods of adjustment of the potentials of its various electrodes for stability and permanence of calibration will be of interest. The extent to which the calibration is affected by the various sources of inconstancy will also be given quantitatively.

The wavemeter, which is illustrated in Fig. 6, is shown diagrammatically in Fig. 7. The variable condenser unit is thoroughly screened so that the proximity of the hand and body during operation does not change the frequency of generation. The inductance of the oscillatory circuit is placed in the centre of another screened compartment to the rear of the condenser unit. The coil and condenser are joined by rigid linking straps and the only other high potential lead of the wavemeter—the lead *l*—is also a rigid fixed capacity link.

The wavelength range covered is 150–10,000 metres—ten range coils each with two capacity ranges sufficing to give the requisite scale reading accuracy of 1 to 4 parts in 10^5. This type of wavemeter can be constructed with a range extended down to 30 metres if desired, without loss of accuracy or stability, by a method which will, if possible, be explained in a future article on the subject.

In selecting the type of screened grid valve for use with this wavemeter, the permanence

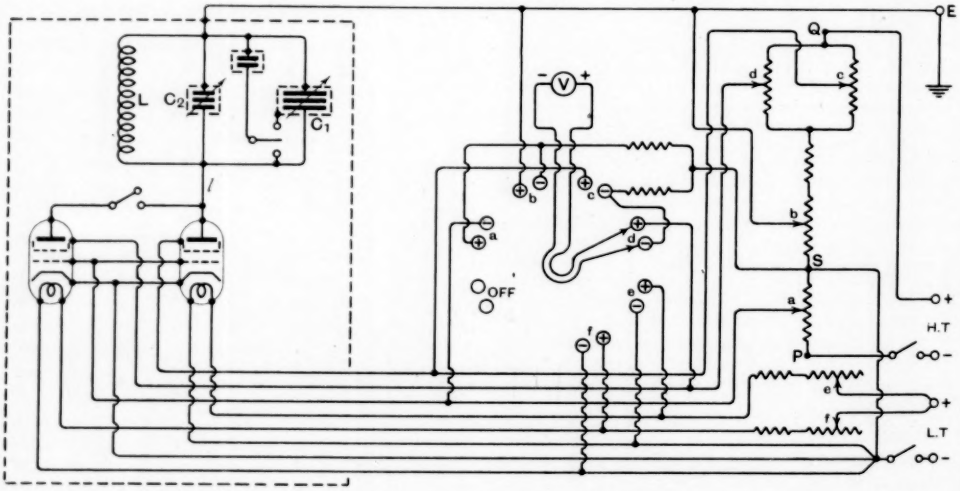


Fig. 7.—*Connections of Sullivan-Griffiths dynatron oscillating wavemeter.*

* A. W. Hull, *Proc. I.R.E.*, Vol. 6, pp. 5–35, 1918.

† "The Dynatron Oscillator," *The Wireless Engineer*, Nov., 1931.

‡ "On the Influence of Valve Resistance in Oscillation Generators," *The Wireless Engineer*, March, 1932.

of capacity between anode and all other electrodes was naturally given first consideration since this capacity is in parallel with the main oscillatory circuit capacity. An

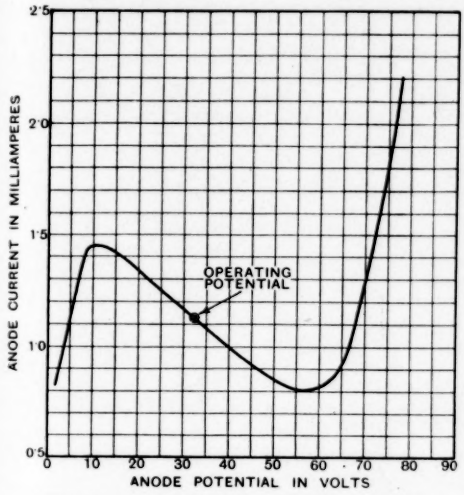


Fig. 8.—*An ideal negative characteristic.*

inconstancy of this interelectrode capacity therefore directly affects the calibration of the wavemeter.

The valve which was found to be most suitable in this respect, without having the usually attendant disadvantage of high resistance, was the Mullard S.4VA. The anode isolation capacity of this valve is very low (about 4 $\mu\mu$F) due to ample separation between the central screen electrode and the two small area flat anode plates which are supported rigidly on either side of it. In addition to being an essential feature for the preservation of the calibration of the wavemeter, this low valve capacity is also an advantage in rendering the calibration independent of valve replacement—for the differences between the capacities of individual valves are likely to be less if the order of actual capacity is lower. This latter advantage becomes more important since a selection of valves has to be made in order to obtain voltage-current characteristics similar in some respects, thus a second selection for capacity similarity is rendered impracticable.

In a simple oscillatory circuit the condition for the maintenance of oscillation is necessarily one which, in effect, reduces the internal series resistance R to zero. An external resistance, r, such as a valve connected in parallel across such a circuit, to be the "loss-equivalent" of R, must have the value L/CR.

This shunt would obviously, in effect, increase the internal resistance of the oscillatory circuit to the value $2R$. If now r is made "negative" by adjusting the electrode potentials of the valve so that the reciprocal of the "slope" *at the operating point* of an anode current-anode potential characteristic (such as is shown in Fig. 8) is equal to $-r$*, then the internal resistance of the oscillatory circuit is reduced to zero and oscillation is maintained.

If the negative resistance of the valve is not exactly equal, numerically, to L/CR but has another value, r_v, then its effect, internally, upon the oscillatory circuit is equivalent to the insertion of a negative series resistance

$$R_v = \frac{L}{Cr_v}$$

It is obvious, therefore, that oscillation cannot be maintained if r_v is greater than L/CR for then R_v will be less than R and the

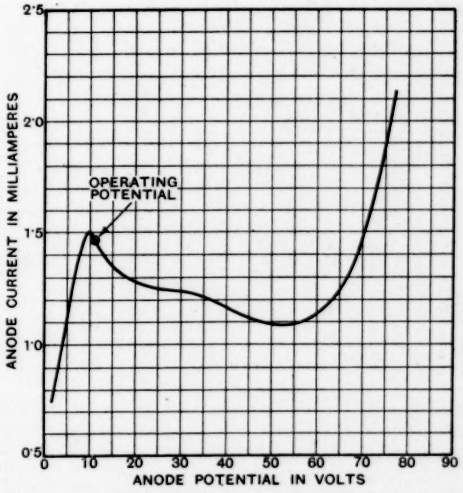


Fig. 9.—*An imperfect negative characteristic.*

* By a negative resistance $-r$ is meant the reciprocal of the "slope" of the characteristic. This is a differential resistance $\delta V/\delta I$ and is negative because the tangent of the angle of slope is negative.

resistance of the circuit will, in consequence, remain positive.

The condition for the maintenance of oscillation is therefore

$$r < \frac{L}{CR}$$

where r is the negative resistance of the valve at the exact operating point on the characteristic.

In a well-designed oscillatory circuit of constant inductance and variable capacity, the value of L/CR diminishes as C is increased owing to the fact that the resistance of the coil (where most of the circuit loss resides) does not vary so rapidly with frequency as the capacity by which that frequency is varied. It is clear, therefore, that in such a circuit r must be adjusted to be less than L/CR for the highest capacity—considerably less, in fact, in order to allow a factor of safety. It follows that at the low capacity end of the range L/CR will be greatly in excess of r even though, as in this wavemeter, the ratio of maximum to minimum capacity is quite limited. Under these conditions, therefore, the approximate frequency modifying factor* of the valve circuit, $R/2r$, will be greater than would be the case for an oscillatory circuit of fixed frequency in which the valve circuit conditions were adjusted to *just* maintain oscillation. The valve characteristic must be adjusted, therefore, to give only a reasonable factor of

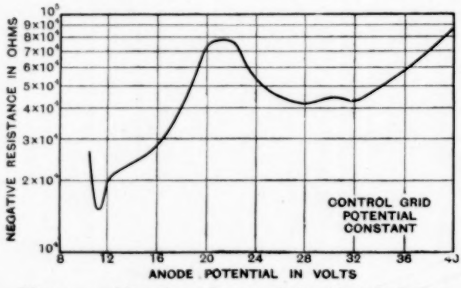


Fig. 10.—*Negative characteristic plotted from measurements made over a wide range of anode voltages.*

safety over the "just maintenance" condition at the high capacity end of each range. This "slope control" may be most conveniently effected by varying the potential of the control grid of the valve.

The adjustment of working slope together with the selection of the best anode potential for an operating point would be a simple matter if the valve characteristic were practically linear with a gradually decreasing

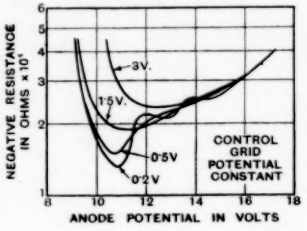


Fig. 11.—*Curves of effective negative resistance measured at audio-frequency for various amplitudes of oscillation.*

slope at either end to gently limit the oscillatory swing as in Fig. 8, where the best operating point would be o. But the characteristics are often somewhat as shown in Fig. 9, where the obviously best operating point for a small amplitude oscillation is marked.

The Selection of Valves and Operating Conditions

Because of this it was found impossible to select valves suitable for this wavemeter without carefully exploring the negative resistance characteristics of a large number of valves. This was effected, at an audio-frequency, using the circuit arrangement described by Dingley in *Proc. I.R.E.*, Vol. 19, No. 11, 1931. A typical characteristic measured in this way is shown in Fig. 10. Upon still further exploring the lowest resistance portion of the characteristic, the curves of Fig. 11 were obtained for various amplitudes of anode potential "swing." In passing it should be noted how, as the amplitude of swing is allowed to build up, each curve of successively higher amplitude exactly smoothes out the local irregularities of the previous smaller amplitude curve as one would expect. The effective negative resistance, of course, increases with amplitude owing to the extremely short length of steep portion of the characteristic and this variation must be taken into consideration when estimating the modification of the natural frequency of the circuit by the valve.

Upon reference to Fig. 11 it will be seen

* $\omega = \frac{1}{\sqrt{LC}}(1 - R/2r)$ very approximately.

that the lowest negative resistance of the valve occupies a portion of the characteristic corresponding with only 1 volt difference in anode potential but, fortunately, upon an examination of the characteristics of Fig. 12, it will be seen that a number of valves may be selected in which the minimum negative resistances occur at exactly the same value of anode potential.

It is possible by a selection of this kind to obtain valves which may be used as spares without affecting the calibration of the wavemeter and which will work together in parallel in order to obtain a sufficiently low value of negative resistance for dynatron operation on the highest frequencies where L/CR is necessarily of a low order.*

It will be seen from the diagram of Fig. 7, that when the valves are in use in the wavemeter the potentials of screen grid, control grid and anode electrodes are governed for each range by adjustment of potential dividers fed by a constant current from one high tension accumulator battery, the whole supply circuit PQ having its potential fixed relative to the cathode of the valve by a connection at the point S.

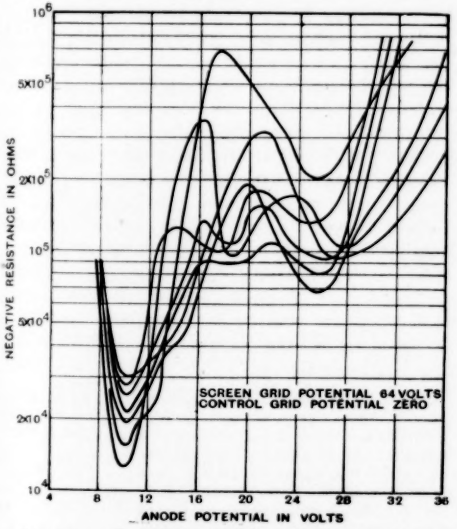


Fig. 12.—*Complete negative resistance curves for a number of S4VA valves.*

The potential adjustment of the screen grid is, of course, not critical but the anode potential must be adjusted critically in view of the knowledge gained in taking the A.C. characteristics, a very small alteration of the potential of this electrode at any point between 8 and 12 volts being sufficient to effect large changes in valve resistance as will be seen in Fig. 12. The potential of the control grid is now adjusted to a "just maintenance" condition of oscillation using a definitely predetermined factor of safety criterion in order to provide for the even tuality of an increase (numerically) of the negative resistance with the ageing of the valve.

(To be concluded.)

* Because L ∝ turn S^2 and R ∝ turns, therefore L/CR for a given capacity is very approximately proportional to the number of turns on the coils provided that they are of correct size and shape to permit the use of the correct gauge of wire required to make them of roughly constant power-factor irrespective of inductance value.

Book Review

Il Proiezionista di Film Sonori—The Sound Film Operator

By E. Costa. Ulrico Hoepli, Milan. 441 pp. 20 Lire.

The writer describes his work as a practical manual for the sound film operator, for the complete comprehension of his equipment and for the tracing of faults. Indeed, the thoroughness of his treatment would seem to justify his claims, even though one may retain a certain cynicism as to the effectiveness of "book-learning," unaided by actual experience, when the scholar is confronted in reality with the terrifying experience described in Question 514: "The volume of reproduction decreases during the projection and finally ceases completely: what is to be done?" Thus Chapter I. begins at the very beginning, with the production and propagation of sound waves, the usual vibrating blade and tuning fork being brought into service; but it ends with a perfectly practical discussion of the reverberation conditions in an auditorium necessary for good reproduction. Similarly Chapter II. begins with elementary matter about electronic emission, but ends with an exposition of the characteristic curves of a push-pull stage and of the use of pentode valves. Chapter III., on the photo-electric cell, is shorter, but even here the writer finds room to mention the photovoltaic cells which are finding practical application in America. Other comparatively short chapters deal with electric pick-ups (for those systems using discs), rectification and smoothing of the mains supply, amplifiers, volume control; then a long chapter discusses the various types of loud speaker. A short chapter on Recording—variable area, variable density, and disc—introduces the *pièce de résistance* Chapter X., on Projection. The remaining chapters deal with subsidiary apparatus, testing, and the tracing of faults. There are 242 illustrations, ranging from characteristic curves to photographs of actual commercial equipments.

Automatic Volume Control for Radio Receivers*

By C. B. Fisher

(*Engineering Department, Northern Electric Company, Montreal*)

ABSTRACT.—The value of automatic volume control for radio receivers is discussed, with a description of American developments up to the present time. Details of a typical circuit are given, and the curves of its operation are shown. Various limitations on the circuit are considered.

1. Introduction

AUTOMATIC volume control (or A.V.C., as it is commonly abbreviated) is a phrase used to describe the operation of a circuit in a radio receiver, so that signals are always heard with substantially the same loudness, irrespective of the signal strength received from the transmitting station. A more correct phrase would be automatic *gain* control. That is, once the listener has adjusted his receiver to give him the desired volume, changes in signal strength due to fading cannot be detected by changing loudness unless the signal strength drops below some minimum value, which will depend on the particular receiver.

Receivers incorporating automatic volume control have been on the Canadian and American markets for some years, and at the present time there is almost no model of any pretensions which does not include an automatic volume control circuit. As the advantages become more generally apparent to the buying public, and as competition between manufacturers becomes keener due to sales saturation and to further advances in design and production, it may be expected that receivers in even the lowest price classes will include circuits with automatic control.

2. Usefulness

When receivers using automatic volume control circuits first appeared the idea met considerable opposition among engineers. This opposition has for the most part disappeared, as it is now more generally realised that advantages are gained which are not immediately apparent, and as more suitable designs are now available.†

The most obvious use of A.V.C. is to minimise the effect of atmospheric fading of signals. Until the signal has faded below the noise level, or below the limiting value which can be handled by the receiver, the output level from the speaker will remain dependent only on the original modulation. This feature is particularly valuable in the case of a highly sensitive receiver which will be used frequently on distant stations, whose signals are particularly subject to fading. Experience has shown that transmissions of medium frequencies (500 to 1,500 kc) will often undergo amplitude variation of 40 db. or more with comparatively little modulation distortion. Where fading is more severe, it is usually accompanied by some modulation distortion, so that an anti-fading device cannot restore to the signal its pristine quality. However, the reception will be more satisfactory than if the anti-fading circuit were inoperative.

* MS. received by the Editor, Oct., 1932.

† W. T. Cocking, in an article in *The Wireless World*, 12th August, 1932, p. 116, states that no British receiver includes an A.V.C. circuit, and points out that the British radio engineer is not yet convinced of the value of such a circuit. The present writer cannot find himself in agreement with Mr. Cocking's conclusions as to the value of A.V.C. and suggests that anyone desirous of forming an opinion on the subject should provide himself with a really first-rate receiver equipped with A.V.C. and make wide use of it for several weeks. As Mr. Cocking says, "This is by no means a technical matter; it is more a psychological point upon which both the technical and non-technical are equally competent to judge." Our experience has been that when an acute but non-technical listener has used a receiver with an A.V.C. circuit he will never willingly return to one not so equipped. In the cases of automobile receivers, and receivers operating on commercial point-to-point circuits subject to fading, there can of course be no question of the value of A.V.C.

In well-designed commercial receivers it has been found easily possible to secure receiver output variations not greater than 6 to 10 db. with carrier input variations of 80 db. or more, say from 10 microvolts to 100,000 microvolts. In fact with many of the receivers on the American market the listener will cease to listen to a station not because the signal fades to inaudibility, but because while the signal output is satisfactory the noise level may become objectional at periods of extreme fading.

A similar application of A.V.C. circuits which has recently become important is their use in automobile radio receivers, both for police patrol and for entertainment purposes. Here the rapidly changing location results in very sudden and severe " fading," rendering manual volume control nearly impossible. At frequencies near 1,000 kc it is not unusual to find in city streets within a few miles of the radio transmitter, variations of field strength of some 40 db., say from 100 microvolts to 10,000 microvolts per meter, in the space of a few feet, representing a time of less than a second for a moving car. This condition becomes more severe as the frequency is raised, and as frequencies assigned for police work in the American cities lie as high as 2,450 kc, the problem is of special interest. Further factors in police work which necessitate A.V.C. circuits are the low power available for transmission (500 watts maximum unmodulated antenna carrier power) and the operation of the patrol cars in solidly built-up districts, where radio " shadows " are more marked. It is also extremely undesirable for the patrol cars to lose touch with the transmission for even short periods, so that the receiver performance requirements are quite rigid. Police transmissions are usually deeply modulated in order to make the most use of the limited power available, and also a high degree of intelligibility is required. Both of these factors render difficult the design of the A.V.C. circuits, as will be discussed in detail below.

Another advantage of a receiver equipped with A.V.C. is that there is prevented the terrific din that results when a careless user is exploring the broadcast band for distant stations and suddenly tunes across a powerful local transmitter. With receivers in common use capable of delivering amounts of power of the order of 10 watts to the loud speaker, some such safety device becomes almost imperative.

The remaining advantages which we shall discuss here are entirely angles seen from the viewpoint of the design engineer. The first has to do with detector performance. The modern anode bend linear detector requires for best operation that the input voltage should be between somewhat close limits, the upper limit being set by the commencement of grid current, the lower limit occurring at the point where the detection diagram departs sensibly from linearity. The A.V.C. circuit holds the input voltage well within limits, so that a condition of nearly ideal detection can be attained.

The other distinct advantage of A.V.C. from the designer's point of view is that it provides a second gain control for the receiver. When we consider that the modern high-gain receiver must handle input voltages of from, say, 50 microvolts to 200,000 microvolts, and must deliver at the will of the operator an output level of from 10 milliwatts or less up to 3,000 milliwatts or more, the volume control problem becomes immediately apparent. The above limits correspond to a change in voltage amplification of roughly a million to one, or 120 db. With manual volume control the attenuation is generally introduced ahead of the detector, often as combined control of input voltage, and regulation of tube gain, in order to secure sufficiently great variation in overall amplification. In a receiver employing A.V.C. on the other hand, the A.V.C. circuit takes care of changes in gain made necessary by different input voltages and a manual volume control is introduced into the circuit subsequent to the detector, and by this means the output level from the receiver is adjusted to the desired value. Thus the variation in gain is divided between the radio-frequency and audio-frequency amplifiers with the result of better detector performance, as has been seen, better radio-frequency amplifier characteristics, as will be seen later, and finally minimisation of microphonic or other noise introduced by the detector or other parts of the audio-frequency circuits ahead of the manual volume control. For at low output volumes with moderate signal strength extraneous noises are attenuated by the manual volume control in the same

ratio as the music or speech, and only reach their maximum when the audio amplifier is operating at full gain. Such an advantage might be gained to a limited degree even in a receiver not incorporating an A.V.C. circuit by providing a second gain control, in the audio-frequency amplifier, and ganging it with the conventional radio-frequency control. The present writer hopes to discuss this problem in more detail in a subsequent article.

3. Requirements for an A.V.C. Circuit

The principal requirement of an A.V.C. circuit is that the operation of the control circuit should depend only on the strength of the incoming carrier, *i.e.*, the control should be independent of modulation. Only if this is true can the receiver output faithfully follow every change in amplitude of the original sounds producing modulation of the transmitted carrier.

For the control to be of utility the A.V.C. circuit must hold the output level within quite close limits, say 6 to 12 db., for wide variations in incoming carrier voltages, say 60 to 80 db., the depth of modulation remaining constant.

This point brings up the further consideration that the A.V.C. circuit should not operate to reduce the receiver gain until the signal input has reached a value sufficiently high to cause the receiver to deliver nearly its maximum output. Conversely the gain control must be sufficiently effective on signals from powerful local transmitters to prevent overloading of the final r.f. amplifier tube or of the detector.

The requirements on the speed of the control action vary widely in the different applications. In automobile receivers it has been found of advantage to provide an A.V.C. circuit which can reduce the gain of the receiver 40 db. in less than one-tenth of a second. For point-to-point receivers on circuits subject to rapid fading the control action may be as slow as half a second for a 40 db. change in gain. In receivers intended for broadcast reception it is becoming usual to find circuits which will operate to reduce the gain quite quickly, but which take several seconds to allow the gain to rise 40 db. This feature is introduced in order to give freedom from noise while tuning quickly from one powerful station to another. Since this is the usual procedure, the listener is not bothered by the background of noise which is heard if the receiver is allowed to rise to its maximum gain immediately it is detuned from the incoming signal. At the same time the period of fading at the broadcast frequencies lying in the neighbourhood of 1,000 kc is usually comparatively long and the A.V.C. is able to follow the changing amplitude of the signal.

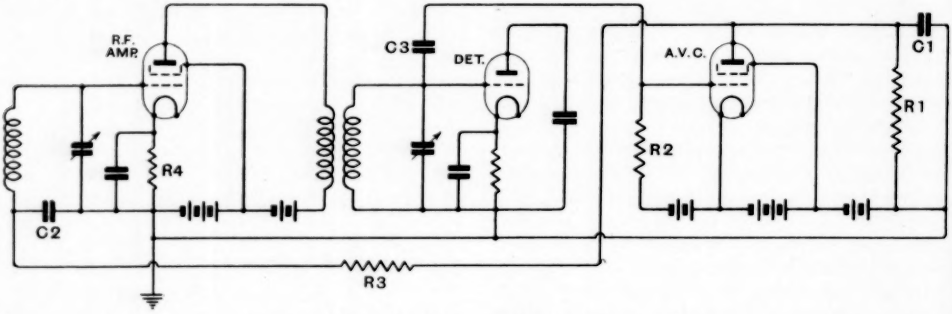


Fig. 1.—*Schematic diagram of the A.V.C. circuit.*

4. Methods of Securing A.V.C.

The most usual A.V.C. circuit is shown in Fig. 1. The control tube may be either a three- or four-electrode valve, but is more commonly the latter. The radio-frequency voltage applied to the detector grid is also applied through a blocking condenser to the grid of the control tube. In some circuits the r.-f. voltage is taken from the plate of the last r.-f. amplifier tube. The control tube is

biased to a point at or beyond plate-current cut-off. Thus no plate current flows until the r.-f. voltage on the grid has exceeded some predetermined value. At this point, however, due to the non-linear characteristic of the tube, direct current begins to flow in the plate circuit. This current flows through a resistance and the resulting voltage drop is applied as a negative bias through a resistance-capacity filter to the grids of the r.-f. amplifier tubes, with a consequent reduction in gain. The circuit quickly settles down to a state of equilibrium.

Notice that the total battery voltage necessary is equal to the sum of the r.-f. amplifier plate voltage and minimum grid bias plus the control tube plate voltage and grid bias. In commercial broadcast receiver design these values are commonly 180, 1½, 45 and 3 volts, respectively. Common practice has been to use the grid-bias voltage of the audio output stage, also as plate voltage for the control tube. Notice also that the cathode of the control tube is at a potential lower than the cathode of the r.-f. amplifier tubes by an amount roughly equal to the plate voltage on the control tube. This condition militates against the use of filament-type tubes, unless a separate filament-current supply is provided for the control tube.

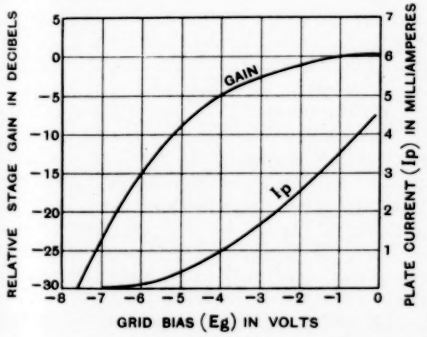


Fig. 2.—*Amplifier characteristics of American type* '36 *tube for plate voltage* 135, *screen voltage* 67.

With tubes having indirectly heated cathodes in circuits where the heaters must be connected to a common supply, the plate voltage of the control tube is limited, generally to 45 volts, in order not to break down the insulation between heater and cathode in the control tube. In special applications, however, where sensitivity of control is more important than tube life or economy, plate potentials as high as 135 volts have been used on the control tube.

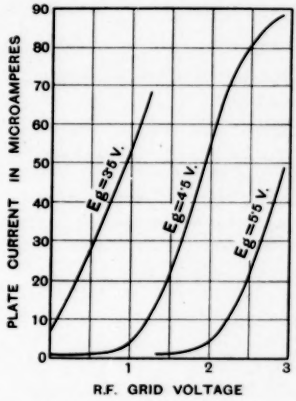


Fig. 3.—*Characteristics of control tube.*

Several other schemes have been devised to secure A.V.C. such as the use of mechanical relays which are operated by the plate current of the control tube and which switch attenuating networks into the amplifier circuit. Also patents have been taken out on a circuit in which the gain of the r.-f. amplifier is reduced by a change in screen voltage, rather than by a change in grid bias as described above.

Two recent developments that promise to become of considerable importance are the Wunderlich tube, and the duo-diode tube. The Wunderlich tube is designed to operate as a grid-leak detector handling comparatively high input voltages with good modulation characteristics. By a suitable arrangement of the circuit, the d.-c. drop across the grid leak due to the incoming signal is applied as a bias to the grids of the r.-f. amplifier tubes, so that automatic gain control is achieved.

The duo-diode tube can be used in a similar manner to obtain automatic control. As the name implies, the tube includes two diodes, which can also be used, one as a detector and one as a rectifier supplying bias for an A.V.C. circuit. In this case the two functions are quite separate so that no detection qualities

need be sacrificed to secure a satisfactory control action. It is further apparent that even the usual bias detector can be arranged so that the increased plate current due to an incoming signal will cause an increased bias to be applied to the r.-f. amplifier tubes, thus securing a measure of automatic control of gain.

5. Performance of Typical Circuit

The following paragraphs under this heading show the results that may be obtained by the most usual type of A.V.C. circuit. While the curves apply exactly only to one circuit using a particular type of tube, nevertheless the performance may be duplicated or surpassed by the use of almost any modern screen-grid valve.

In the circuit of Fig. 1 the following values of the components are used:

R_1 500,000 ohms	C_1 0.1 mfd.
R_2 1 megohm	C_2 0.1 mfd.
R_3 100,00 ohms	C_3 0.0001 mfd.
R_4 300 ohms	

The three tubes shown are type '36, as made by a number of manufacturers in Canada and the United States, and are heater-type screen-grid tubes intended primarily for use in automobile receivers. In Fig. 2 are shown curves for this tube as an amplifier. That is, plate current (I_p), and relative gain per stage (G) are shown as functions of grid bias, for a plate voltage of

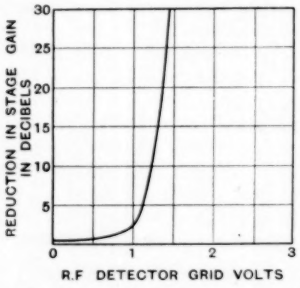


Fig. 4.—*Reduction in gain of one amplifier due to action of control tube.*

135 and a screen-grid voltage of 67. The relative gain per stage has been computed on the assumption that the voltage amplification per stage is proportional to the mutual conductance of the tube, and the gain with the minimum grid bias (*i.e.*, the bias due solely to the voltage drop across resistance R_4) has been arbitrarily denoted zero db.

The additional data required deal with the performance of the gain-control tube and are

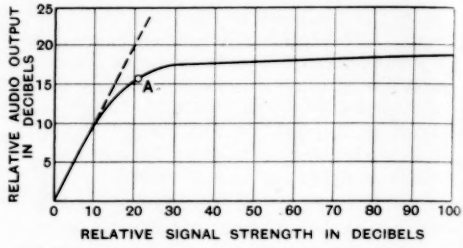


Fig. 5.—*Load curves of a receiver with 3 stages of H.F. amplification using American type '36 tubes. Point "A" corresponds to 1.0 volt R.M.S. on detector grid. Solid and dotted lines show operation with and without A.V.C., respectively.*

shown in Fig. 3. Curves are shown of plate current against R.M.S. radio-frequency voltage applied to the grid, for a number of values of grid bias. The plate voltage is 45, the screen voltage 22, and the plate resistor 500,000 ohms in each case. The two latter values were determined to be the most suitable by a series of measurements. For the sake of an example we make the assumption that the r.-f. voltage on the detector grid is to be allowed to reach 1.0 volt R.M.S. before the control is to act to reduce the gain to any extent. Referring to Fig. 3 again we see that the curve $E_g = 4.5$ volts would meet this condition. We can now readily plot the bias voltage supplied to the r.-f. amplifier against a.-c. voltage on the detector grid. By combining this information with that derived from Fig. 1 we are enabled to plot the curve of Fig 4, which shows the change in gain per stage of the r.-f. amplifier against input voltage to the detector grid. From this curve by an obvious process have been derived the data leading to the curve of Fig. 5, which has been called the "load curve" of the receiver. This shows the variation of audio output voltage with the r.-f. input voltage to the receiver, and has been drawn on the basis of three similar r.-f. stages, linear detection, and constant depth of modulation.

We have now secured the desired performance curve of the A.V.C. circuit. The

circuit has been seen to act in the desired manner. The r.-f. gain suffers no reduction until the detector voltage rises above 0.5 volt. At 1.0 volt the reduction is only $7\frac{1}{2}$ db. In order to increase the detector voltage an additional 2.5 db., it is necessary to increase the signal input to the receiver by 80 db.

6. Limitations on A.V.C. Circuits

So far there has been no mention of the difficulties introduced by the operation of the A.V.C. circuit. The first of these is its influence on r.-f. amplifier characteristics. Due to the fact that the gain must be varied over a wide range by a variation in grid bias alone, cross-modulation and rise in modulation are apt to occur in the amplifier tubes. Earlier designs for receivers avoid this condition by using "local-long distance" switches which are intended to introduce attenuation into the antenna circuit when powerful signals are being received, and also by arranging the circuit in order to secure most of the variation in gain in the earlier r.-f. stages, where the signal voltage is low. The variable-mu tube was introduced several

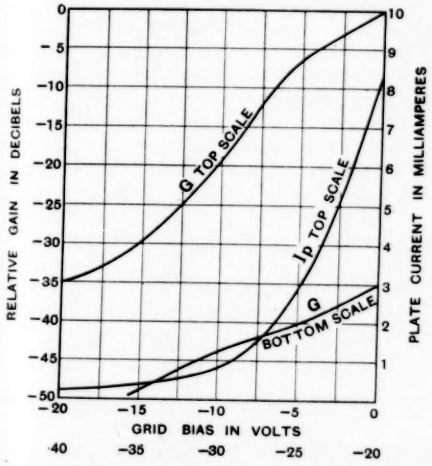


Fig. 6.—*Amplifier characteristics of American type '39 tube for plate voltage 135.*

years ago mainly to meet the conditions in this circuit, and has solved the problem admirably. These tubes, however, have mutual conductances which in some cases decrease comparatively slowly with increasing grid bias, so that a load curve of as satisfactory a shape as that of Fig. 5 cannot be obtained in every case. As an example of the use of a variable-mu tube the curves of

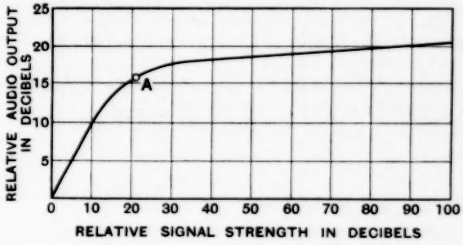


Fig. 7.—*Load curve of a receiver with 3 stages of H.F. amplification using American type '39 tubes. Point "A" corresponds to 1.0 volt R.M.S. on detector grid.*

plate current and mutual conductance versus grid bias are shown in Fig. 6 for a type '39 tube. This is a variable-mu r.-f. pentode. designed for automobile use. The corresponding load curve of a receiver employing three of these tubes as r.-f. amplifiers is shown in Fig. 7. It is seen that a very satisfactory degree of automatic volume control has been achieved.

The other principal difficulty is the effect on the gain-control circuit of the modulation of the incoming signal. Consider the action of the gain-control tube when an unmodulated carrier of 0.5 volts is being applied to its grid. Fig. 3 shows that practically no plate current flows and the gain of the r.-f. stages is not reduced. If now the carrier is completely modulated at an audio-frequency rate, the voltage on the grid of the control tube will reach 1.0 volts at the peaks of the audio-frequency wave. Plate current will then flow intermittently in the control tube. Audio-frequency components will be severely attenuated before reaching the grids of the amplifier tubes, but the a.-c. component will cause a reduction in gain, which is not desirable.

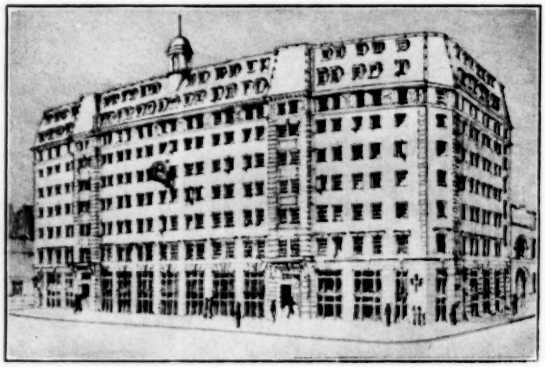
Two things may be done to minimise this effect. First, the action of the control is made slow by suitably proportioning condensers C_1 and C_2, and resistance R_3 of Fig.1. The gain is then reduced under the above conditions by an amount corresponding to the average depth of modulation over a period of time. As this average depth is usually

quite small, and changes slowly, the effect of modulation on the gain-control circuit becomes less noticeable. The second method of securing improvement is to use circuit values which give curves similar to those of Fig. 3, but of smaller slope. This change results in a less satisfactory load curve for the receiver, but is generally made in order to secure freedom from modulation distortion.

Another factor which requires consideration in a receiver using A.V.C. is the question of tuning. The effect of the control circuit is of course to make the receiver appear less selective, particularly with powerful signals. In the case of highly selective receivers it is important that the receiver be tuned accurately to the incoming carrier, and to assist in this it is usual for the receiver to include a "tuning meter." This is simply a milliammeter connected in the plate circuit of one or more of the r.-f. amplifier tubes. As the A.V.C. circuit acts to reduce the plate current of these tubes, the tuning dial is adjusted to cause the meter to read a minimum value. Other devices are in use such as a light which is made to glow with the minimum brightness and so on.

7. Conclusion

Automatic volume control may be a cure for some of the evils which beset a radio receiver. It is an extremely cheap addition to an existing design as, apart from the provision of one tube, practically nothing but the most inexpensive of components is required in the way of additional apparatus. A receiver designed to include an A.V.C. circuit must of course meet several conditions; it must have a detector designed to receive comparatively high voltages, and the r.-f. amplifiers must be capable of sufficient variation in gain to meet the conditions of signal variation. No other limitations are imposed by the A.V.C. circuit.



CHANGE OF ADDRESS

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WIRELESS ENGINEER

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A Wavemeter with Alternative Close and Open Scales *

Communicated by the Staff of the Radio Research Station, Slough

SUMMARY.—An absorption wavemeter is described which can be used (*a*) with a wide frequency range, (*b*) with a restricted range and correspondingly greater openness of scale. Observations are made on the calibration of such wavemeters, and their use in connection with receiving apparatus. The use of the principle in receiver tuning is noted.

THE simple arrangement described below does not appear to be generally known or used.

The principle of the wavemeter is shown in Fig. 1, where C is the variable condenser, and the inductance L a plug-in coil. When

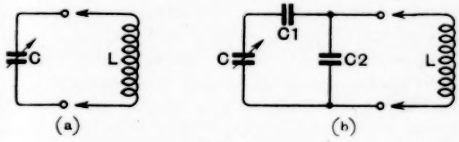


Fig. 1.

using the wavemeter in the normal (wide range) condition, the circuit is as at (*a*). In order to open out the scale over a predetermined range (for instance, one of the frequency bands allotted to amateur transmitters) the circuit (*b*) is used, introducing two extra fixed condensers. The effective capacity connected across the inductance is now $C_2 + C_1 C/(C_1 + C)$, and by suitably proportioning the values of C_1 and C_2 it is possible to obtain any desired openness of scale, around any particular frequency (or setting of C in Fig. 1 (*a*)). The condition shown in Fig. 1 (*b*) will be referred to as the " spread-band " arrangement.

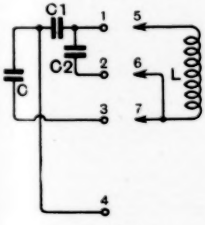


Fig. 2.

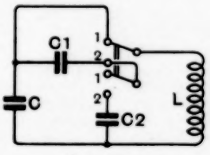


Fig. 3.

The change of the connections from (*a*) to (*b*) can be effected in many ways; a simple method, requiring no switches, is shown in Fig. 2.

Here 1, 2, 3, 4 represent terminals or sockets—so spaced that the distances between 1 and 3, 3 and 4, are equal. The coil is fitted with three plugs, 5, 6, 7, the last two being linked together. In the normal condition the coil is plugged in so that 5 and 7 enter 3 and 4. The condenser C alone is then across the coil. In the spread-band condition 5, 6 and 7 are plugged into 1, 2 and 3, so that the condition of Fig. 1 (*b*) is attained. Another arrangement, employing a double-pole 2-way switch, is shown in Fig. 3. In the wavemeter shown in Fig. 2, embodying this principle, C is a 0.0002 μF variable condenser (square law), C_1 is a trimmer set at 29 $\mu\mu$F., C_2 is a preset condenser set at 42 $\mu\mu$F. The wavemeter is supplied with a set of four coils covering a range of 2.1 — 40 Mc/s (normal), with spread-band ranges 3.6 — 3.86, 6.94 — 7.45, 13.66 — 14.8, 27.7 — 29.7 Mc/s centred approximately on the four amateur 80, 40, 20 and 10 metre bands.† The whole 80 metre band is not covered. Some idea of the scale range obtained can be gained from Fig. 4, where the two calibrations for the 40 metre band coil (4 to 10 Mc/s) are shown. The pointer movement for a 1 per cent.

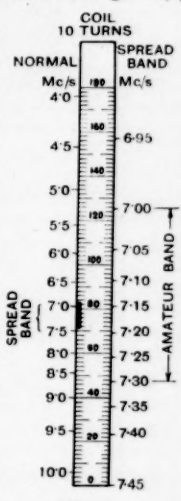
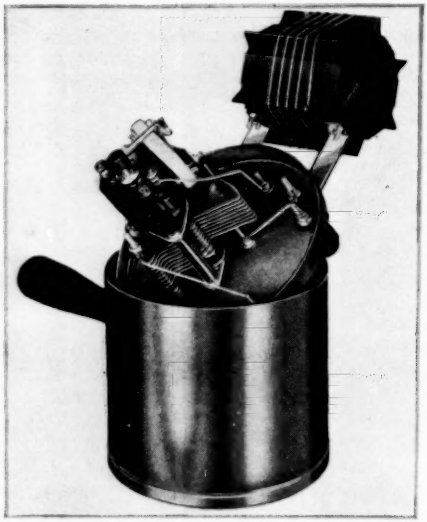


Fig. 4.

* MS. received by the Editor January, 1933.

† Inductances of coils 28.2, 8.0, 2.1 and 0.46 microhenries.

change in frequency on the two scales is shown. The calibration of the spread-band arrangement was first tried by listening to the clicks in the 'phones connected to an oscillating wavemeter, but the settings so obtained were not sufficiently precise, having regard to the slow change of frequency with condenser movement.



Wavemeter opened up.

In order to obtain more accurate readings a grid current meter was connected to the standard wavemeter, the dip in the reading serving as the indication that the wavemeter under test and the standard were in tune. The method was quite satisfactory, but, in order to utilise a wavemeter not fitted with a grid current meter, the following method * was tried out with satisfactory results. In this method the standard wavemeter is made to beat with any other oscillator, a convenient beat frequency (say 1,000 c/s) being obtained. The wavemeter under test is placed near the standard, and, as it is tuned through the frequency of the standard, the note heard will change as shown roughly in Fig. 5. As the condenser is turned the note rises slowly, falls rapidly to 1,000 c/s and below, then rises slowly to 1,000 c/s again. At the setting corresponding to the 1,000 c/s in the region of rapid change the wavemeter under test is in tune with the standard. By causing a local audio-frequency oscillator to generate a 1,000 c/s note, slow beats can be obtained between it and the beat frequency, permitting a very precise setting. The principle underlying the operation is that the frequency of an oscillator is altered by a negligible amount when it is coupled to a circuit which (at that frequency) behaves as a pure resistance. This, of course, is only strictly correct when a weak coupling is used,† but in practice it is found that the " double beat " method is so sensitive that only a weak coupling is required.

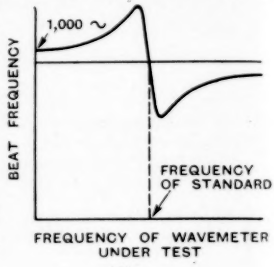
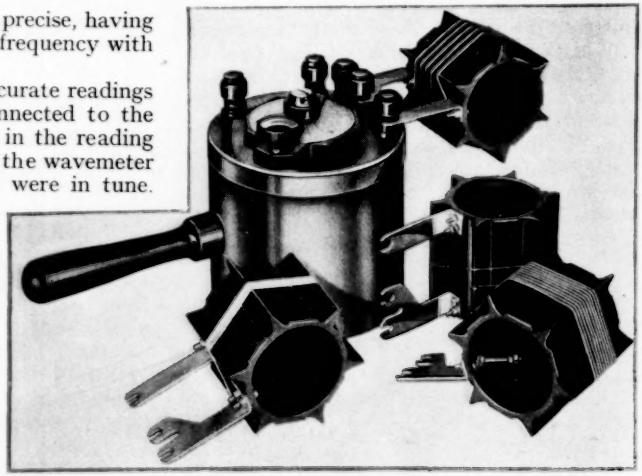


Fig. 5.



Wavemeter with extra coils.

It appears that the convenience of an absorption wavemeter in connection with

* For which no novelty is claimed.

† Colebrook, *Journ. I.E.E.*, Vol. 6, p. 49, 1931.

receivers (as opposed to transmitters) is not sufficiently widely realised. *The absorption wavemeter possesses the great advantage that by its use no confusion ever arises between the fundamental and harmonics of an oscillation.* In determining the frequency to which the receiver is tuned when the receiver contains an oscillating detector, the absorption wavemeter can be brought close to the oscillating circuit, and a click heard on passing through tune. If a signal is actually being received the change in frequency of the beat signal (somewhat as in Fig. 5) can be observed as the wavemeter passes through tune.

In some cases the wavemeter can be coupled to the aerial lead-in, and the drop in signal strength observed as an indication of tune. The principle is clearly not limited in application to wavemeters, but can be applied to receiver circuits.

The device described arose in the course of work carried out for the Radio Research Board, and this note is published by permission of the Department of Scientific and Industrial Research.

Correspondence

Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

Vibrations of a Coil-driven Paper-Cone

To the Editor, The Wireless Engineer.

SIR,—With reference to the paper of F. R. W. Strafford (*Experimental Wireless*, March, 1933, p. 141) the following remarks may be of some interest. These "auxiliary frequencies" have been of some importance in the manufacturing of loud speakers, as they were supposed to be due to faults in the coil, diaphragm, surround, etc. Finally the oscillations were recognised as a natural and quite general peculiarity of the cones. The following observations may complete the description of the phenomenon :

1. The intensity-threshold increases rapidly with increasing thickness or stiffness of the cone paper.

2. With increasing cone diameter the phenomenon goes to lower frequencies.

3. The auxiliary frequency has a very long building-up-transient-period ; near the intensity-threshold periods of three and five seconds can be reached. The building-up-transient-period decreases rapidly with increasing intensity.

4. One can suppress the auxiliary frequency by touching the diaphragm or even, at lower intensities, by putting one's hand near the diaphragm.

5. The phenomenon is indeed, as Mr. Strafford states, a sharply tuned one, but at very high outputs the auxiliary tone is produced in a whole continuous range including the primary frequency.

There is a similar phenomenon in longitudinal vibrations of bars, observed by Savart and called by him "son rauque," explained by Terquem. According to him, as states Lord Rayleigh (Theory of Sound, §158, §68*b*), the phenomenon is analogous to that observed in an experiment of Melde, "in which a fine string is maintained in transverse vibration by connecting one of its extremities with the vibrating prong of a massive tuning-fork, the direction of motion of the point of attachment being parallel to the length of the string. The effect of the motion is to render the tension of the string periodically variable ; and at first sight there is nothing to cause the string to depart from its equilibrium condition of straightness. It is known, however, that under these circumstances the equilibrium may become unstable, and that the string may settle down into a state of permanent and vigorous vibration, whose period is twice that of the fork."

The mathematical theory of these vibrations leads to a Mathieu-differential-equation, a type in which great progress has been made in recent years. This equation has solutions of the half of the causing frequency for certain values of its parameters (see M. I. O. Strutt, Lamésche, Mathieusche und verwandte Funktionen in Physik und Technik, Berlin, 1932) and one can easily see that all the properties of the auxiliary frequency referred to above are given by the theory—though it is given for a system of only one degree of freedom. (One must except, in my opinion, the rule that a constant difference exists between the causing frequencies, which, however, does not seem to be general.) Now, since Mr. Strafford has directly observed the existence of special vibrations connected with the auxiliary frequencies, there is no doubt, I think, that we have really to do with a phenomenon like that in the experiment of Melde.

Berlin. Dr. H. F. O. BENECKE.

Valve Data Diagrams

To the Editor, The Wireless Engineer.

SIR,—In reference to your editorial article of the December, 1932, issue of your Journal, entitled "Valve Data Diagrams," may I point out another improvement that may be introduced into the valve logarithmic diagram.

If we consider that the maximum power output per peak volt squared input that a valve can deliver is given by :

$$\frac{P}{E^2} = \frac{\mu^2}{8R_i} = \frac{Q}{8}, \quad Q \text{ being the "Güte" } (Q = \mu G_m),$$

the scale of the Güte may give an idea of compara-

tive sensitivity of identical power valves, *i.e.*, the output in milliwatts per square volt input. If this power scale is plotted with the divisions proportional to Log Q, there results a very useful scale in bels, or in decibels, easy to divide because it has equal divisions. The zero level may be placed anywhere, for instance, in one milliwatt per one square volt. Of course, it is the maximum undistorted output that the designer considers and not the maximum output. However, for identical triodes or pentodes the fall of efficiency, when we take the recommended load for the undistorted output, does not vary much, 0.4 to 0.8 decibels for triodes and 2 to 4 decibels for pentodes. Taking into account this fact, we may without great error compare two valves by considering the decibels difference given by the chart.

For classification of high-frequency valves we may plot over the axis of the Güte another scale giving the high frequency performance factors :

$$F = \frac{\mu}{\sqrt{R_i}} \times 100 = 100 \times \sqrt{Q}.$$

The maximum voltage gain obtainable with a valve followed by a suitable transformer being $\frac{F}{200}\sqrt{R_d}$ (where R_d is the dynamic resistance), the utility of a scale so constructed is obvious.

The former decibels scale may also be used for the purpose of comparing these valves because the decibels gain is given by :

$$dB = 20 \log G = 10 \log G^2 = k \log Q$$

(k being a constant).

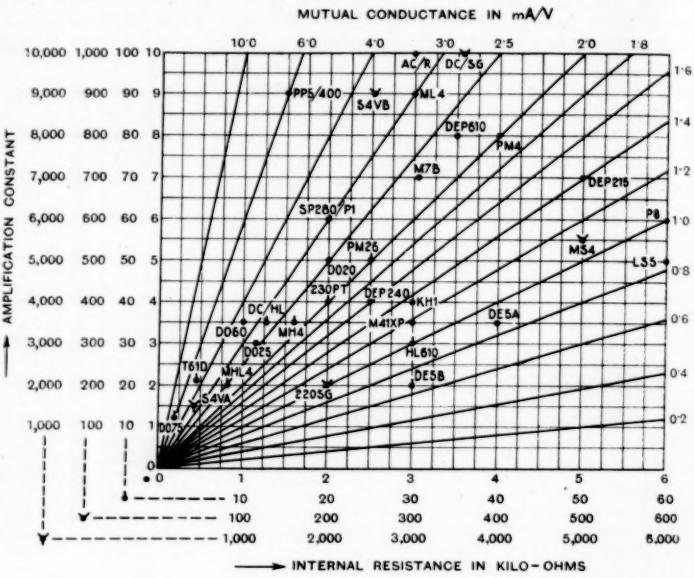
In the February issue of *Radio-Craft* a little article of mine is published on this subject. An example of such a chart is also given.

Lisbon. FRANCISCO PINTO BASTO.

To the Editor, The Wireless Engineer.

SIR,—The editorials in the December issue of the last year and the July issue of 1931 on valve data diagrams interested me much. In this connection it may be of interest to call your attention to the fact that there is another method for the solution of the same problem.

The main feature is to use ordinary rectangular ruled paper so as to facilitate the interpolation of numerical values and the preparation of diagram sheet. As is seen in the accompanying diagram, the characteristics of a valve is represented by a point referred to, the rectangular co-ordinate axis, the abscissa and ordinate being its internal resistance in kilo-ohms and its amplification constant respectively. Then the line from the origin to that point has the same steepness (thus giving the effect of the term " Steilheit ") as the straight part of the static characteristic curves of the valve, when the plate current is plotted in milli-amperes and the grid voltage in volts.



But the disadvantages are : the " Güte " is not conveniently given and the scale of the co-ordinates must be given in multiple to meet the large range of characteristic values.

In the accompanying diagram, several English valves are illustrated by the new method.

ISSAC KOGA.

Tokyo University of Engineering.

The Late Herr Schäffer

THE unexpected death on March 24th of Walter Schäffer, Chief Engineer of the Reichs Rundfunk Gesellschaft, and of his wife, came as a shock to his many friends. Herr Schäffer, who was born in Breslau in 1881, had for many years directed the technical activities of all the German broadcasting organisations, and it fell to him to take an important part in the deliberations of the Technical Committee of the Union Internationale de Radio Diffusion. While his numerous journeys abroad gave him a wide and sympathetic outlook, he put up many a strong fight for wavelengths in the interests of Germany.

The Balancing and Stabilising of High-frequency Amplifiers, with Special Reference to Power Amplifiers for Radio Transmitters

Paper by Messrs. W. Ure, B.Sc., E. J. Grainger, M.Sc., A.M.I.E.E., and H. R. Cantelo, M.Sc., read before the Wireless Section, I.E.E., on Wednesday, 1st March, 1933

ABSTRACT

PART I of the paper is historical and gives an account of the general development of the high-frequency amplifier. Reference is first made to the contributions of H. W. Nichols and J. M. Miller to the more complete understanding of the nature of the problem. Next are discussed the contributions of Rice and of Hazeltine to practical methods of neutralisation.

In Part 2 it is first shown that the methods of both Rice and Hazeltine embody a Wheatstone bridge which has for one pair of its ratio arms the valve anode-grid capacitance and the inductance of either the anode circuit or part of the grid circuit, according to the method used, and for the other pair the balancing capacitance and the inductance of the coil used as the balancing winding. The circuits and their equivalent bridge networks are shown in Fig. 7,* for the Rice method and in Fig. 8 for the Hazeltine method. Various sources of unbalance are then discussed. For example it is shown that a source of unbalance is the presence across the L_1, half of the tuned circuit (Fig. 7) of the grid-filament capacitance and, in parallel with it, the grid-filament conductance, unless the valve is negatively biased. In Fig. 8 the balance is hindered by the presence of the anode-filament conductance and capacitance across L_2.

The authors then refer to the advantage of the push-pull system of amplification, having particular advantages as extreme frequencies are approached. These are (i) the circuits are symmetrically balanced as regards potentials relative to earth, (ii) the

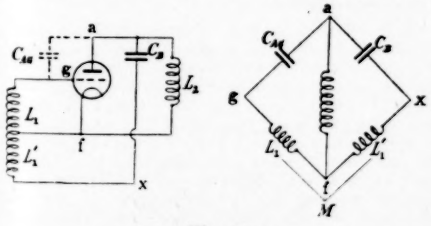


Fig. 7.

capacitance ratio (tuning condenser capacitance)/(valve inter-electrode capacitance) is greater than in the parallel-valve type of circuit for a given value of tuning inductance. A simplified push-pull circuit is shown in Fig. 12 (*a*) with its equivalent balanced bridge in Fig. 12 (*b*).

* The authors' original figure numbers are adhered to throughout this abstract.

The fact that a valve with its associated circuits may be neutralised for the frequency at which it is designed to work is, however, no guarantee that it cannot oscillate at a different frequency which may be a lower or a very much higher frequency. This arises sometimes as the result of undesired resonances among circuit components and sometimes from the presence of stray capacitances and inductances giving different oscillatory circuits. Even the push-pull circuit is capable of generating spurious oscillations, the frequency of the oscillations being so high that the tuned anode-circuit coil can be considered as disconnected. It is not always an easy matter to damp out parasitic oscillations. In cases where the desired oscillations do not suppress the parasitic frequency, common practice is to insert non-inductive resistances of equal value in each of the arms of the bridge. Since the bridge forms part of both the master and

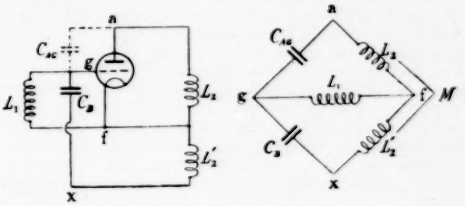


Fig. 8.

main tuned circuits, the insertion of such resistances introduces a certain amount of damping into them: where the desired and parasitic frequencies are sufficiently far apart, general methods of suppression consist in the use of (i) extra capacitance connected between grid and filament of each valve to ensure that feed-back effects are in the wrong phase-relationship to produce regeneration; (ii) series resistance in individual valve anode or grid leads to act as damping resistance; (iii) combinations of paralleled inductance and resistance inserted in individual valve anode or grid leads, so porportioned that the combination has negligible impedance at the desired frequency, but considerable impedance at the parasitic frequency.

The authors then proceed to discuss difficulties of circuit lay-out, stressing the need for symmetry, balance, minimum of undesired couplings, etc., dealing with these points in relation to the push-pull circuit. Other sources of trouble are also discussed, such as multiple earth-leads and secondary emission from valve grids. Next they describe the methods of balancing, for example, hot and cold

balance methods. In the grid-current (hot) method power is applied to both drive and driven stages, the driven stage being detuned. It is then slowly tuned through resonance and observations are made of its grid current which should show no change in value as resonance is passed through, if the

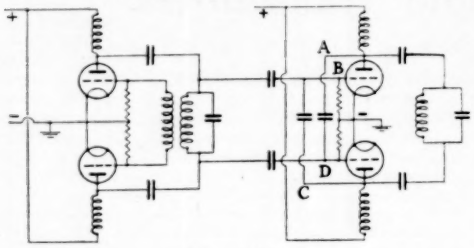


Fig. 12 (a).

circuit is balanced. In the input and output current method, power is applied to both drive and driven stages and the anode-circuit input current and the oscillatory circuit current are noted as the driven stage is tuned through resonance. If the stage is balanced, minimum input current and maximum output current occur simultaneously at resonance. In the most common cold balance method, excitation is applied to the grids of the stage to be balanced with anode potential disconnected. A sensitive thermo-ammeter is inserted in shunt across part of the output tuned circuit which is tuned to resonance. The balancing condensers are then adjusted till the reading of the thermo-ammeter is a minimum.

As regards other methods of eliminating capacity coupling between input and output circuits, reference is made to the screened-grid valve which has not, however, been much developed for transmitting purposes, and to the Post Office Heptode valve which is also in a somewhat experimental state.

Neutralised amplification is, of course, much more readily obtained at the lower radio frequencies than at the higher. Push-pull arrangements are not then necessary and it is usual to excite a power stage (which may consist of a number of valves in parallel) through a series of amplifying stages each consisting of one valve.

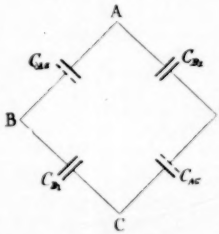


Fig. 12 (b).

Part 3 of the paper discusses unbalanced phenomena observed during the development of a two-stage high-power transmitter for naval ship use. A master drive (Fig. 24) is used in the form of an ordinary Hartley circuit, great care being taken to obtain a balanced voltage swing about the tapping-point of the coil over the whole frequency range. In developing circuits it was found necessary to pay particular attention to the screening of the drive circuit, also to equalising the leads to the grids of the power valves. Tendencies to self-excitation and current unbalance were reduced by shortening all connecting leads and spurious higher-frequency oscillations suppressed by inserting a small resistance in the anode lead.

The power amplifier is of the push-pull type and similar precautions were taken to obtain a balanced layout. Spurious oscillations (of the order of 40,000 megacycles per sec.) were overcome by inserting non-inductive resistances of 1.5Ω in each bridge arm. Care had also to be taken as regards choke resonances.

Part 4 of the paper describes the completed transmitter, designed to employ the output of 20 kW. 500 ~ alternator. Great precautions had to be taken in design and layout in order to comply with the C.C.I.R. regulations within the limitations imposed by the signalling requirements and by the

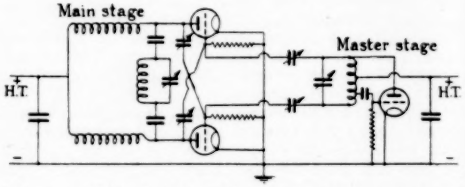


Fig. 24.—*High-frequency circuits of 2-stage amplifier.*

space available. A circuit diagram is given in Fig. 29. The grouping of apparatus is as follows:—

Panel 1.—Medium-frequency master oscillator and low-power transmitter.
Panel 2.—Signalling and absorbing.
Panel 3.—Medium-frequency power amplifier.
Panel 4.—Power distributing and wave indicators.
Panel 5.—High-frequency power amplifier.
Panel 6.—Spark attachment.
Panel 7.—High-frequency master oscillator.
Panel 8.—Small rectifier (feeding master oscillator).
Panel 9.—Main rectifier (feeding power amplifier).
Panel 10.—Smoothing.

An interesting feature mentioned is the design of the coils for the high-frequency master-oscillator, with the object of maintaining an inductance value constant over changes of temperature of the order of 40° C. The turns of the coils consisted of incomplete rings of copper strip, joined in series to form a coil by means of short, bent flexible copper strips. The individual rings were supported at only one point of their circumference by a common rib of micalex running the entire length of the coil. Expansion of the copper rings with heat would normally result in an increase of diameter of the ring, with a corresponding increase of inductance. This is prevented by four cylindrical rollers of micalex placed outside the rings and slightly constraining them. Any expansion of the rings could only take place by the ring closing in upon itself and by the ends approaching each other.

The paper is communicated from H.M. Signal School, Portsmouth, by permission of the Board of Admiralty.

Discussion

In opening the discussion MR. G. SHEARING referred to several points of design in relation to naval ship requirements. High-frequency stability was extremely difficult in self-generating circuits and the transmitter described had to be operated so as to permit change of the tuning as quickly as that of the corresponding receiver. This was greatly helped by the monitoring wave-meter. Another practical point in ship working was that variations of the aerial should make no change of frequency, and this was found to be so with the arrangement shown.

MR. A. J. GILL appreciated the author's difficulties of space and range of frequencies. Referring to methods of avoiding spurious oscillations he suggested several minor modifications, one being the tapping of the anode leads down the inductance of the push-pull amplifier. Concentric condensers were to be recommended for balancing. The latest type of heptode had proved very satisfactory and numbers of these were now in service.

MR. MCPHERSON agreed as to the need for extreme symmetry and referred to a few cases of spurious oscillation that had been met in transmitters up to 50 kW.

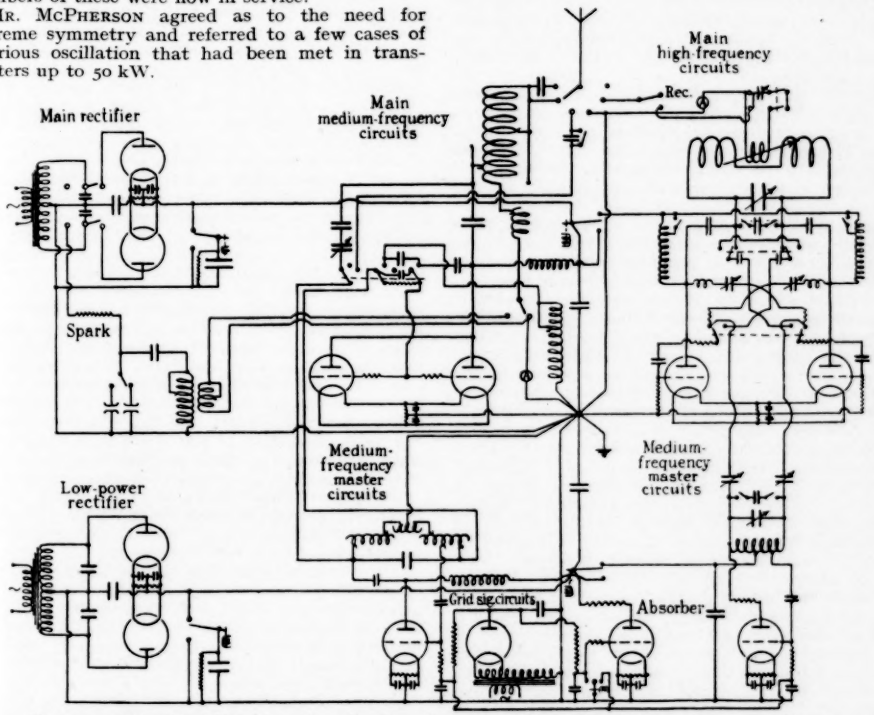


Fig. 29.—*Simplified diagram of combined medium-frequency and high-frequency transmitter: H.T. supply and oscillatory circuits.*

CAPT. MURRAY, R.N., outlined the practical problems posed to the designer of naval apparatus as regards space, mobility of parts, accessibility, ease of control, etc., and referred to the satisfactory solution provided by the authors.

MR. N. LEA referred briefly to the very slight practical differences between the Rice and Hazeltine methods of neutralising. Spurious oscillations could frequently be avoided by having the valve as near as possible to the tuning condenser. These oscillations were due to different degrees of freedom in various parts of the circuits. Sometimes they were only of importance in the transient state, *e.g.*, in telephony, television, etc. In one case a spread of 60 kc/s had been found to be due to keying transients.

COL. A. S. ANGWIN suggested the incorporation of actual performance of the set, particularly of the specification of frequency tolerance and how it was met in practice.

MR. H. FAULKNER referred to several methods used in the elimination of parasitic oscillations in the Rugby transmitter. Demountable screened-grid valves up to 20 kW. were now in construction and promised considerable success.

MR. W. URE replied briefly to several points raised in the discussion. In relation to performance, a transmitter and receiver each tuned to 30 metres and left in this condition, were found to be in tune to each other every day on switching on.

On the motion of the Chairman, MR. L. B. TURNER, the authors were cordially thanked for their paper.

Abstracts and References

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PROPAGATION OF WAVES

THE IONOSPHERE AS A DOUBLY-REFRACTING MEDIUM [Split Echoes due to Magneto-Ionic Double Refraction].—E. V. Appleton and G. Builder. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 208–220.)

This is the paper foreshadowed by Builder (March Abstracts, p. 148). Authors' abstract:—"In a previous communication to the Society [1932 Abstracts, p. 155] the occurrence of wireless echo doublets was described and was provisionally attributed to the influence of the earth's magnetic field on the dispersive properties of the ionosphere. A more extended study of the subject, which has included an experimental determination of the polarisations of the doublet-components, has confirmed this hypothesis. In south-east England, for ionospheric reflection at vertical incidence, the echo-component of lesser delay is, in general, of right-handed, and the component of greater delay of left-handed, circular polarisation, but this temporal sequence should be reversed in the Southern Hemisphere, and in certain special circumstances in the Northern Hemisphere" [see below].

The writers show how the group separation of the components can occur in two ways, by what they christen "stratification splitting" (the most common type, which retards the ordinary component behind the extraordinary component) or by "group-retardation splitting" (due to group retardation in passing through region E before reflection by region F, and retarding the extraordinary component behind the ordinary component). Usually the effect of group-retardation splitting is more than neutralised by that of stratification splitting, so that the first echo-component experienced is right-handed and the second left-handed, as mentioned above. The opposite case has only been observed on frequencies just above the critical range of values for which penetration of the lower region begins to take place; this agrees with previous observation that the group retardation in passing through region E is most marked for such frequencies.

The interpretation of the phenomena associated with reflection from region E is more difficult. The ionisation gradient appears to be greater than in region F, so that simple stratification splitting as indicated by the temporal separation of the two components does not show up so readily; although splitting which appears to be of the same type as that experienced for region F has been noted on many occasions, the writers have not yet been able to make definite determinations of the sense of polarisation of the two (or more) components separately. This point, and the effect of electron-limitation in causing a change in polarisation, is discussed on p. 216. "As has been described for reflection from region F, the effect of electron-limitation in a case in which the ionisation is steadily decreasing is to cause the polarisation to change from the predominantly left-handed rotational sense (when the polarisation is determined by the greater amplitude of the ordinary ray) to the right-handed sense (when, owing to electron-limitation, the ordinary ray has penetrated the layer and only the extraordinary ray is being reflected). During sunset runs we have also sometimes found this to be the case for region E. Using a constant frequency the polarisation has at first been left-handed and later, as the ionisation has decreased, has become right-handed. As the ionisation has further decreased, even the extra-ordinary ray has finally no longer been reflected, and full penetration of the lower region has taken place. Because of these magneto-ionic effects in cases of reflection from the lower region, and of the existence of group-retardation splitting for waves reflected by the upper region, we conclude that the Kennelly-Heaviside layer contains a considerable proportion of free electrons."

The penultimate section deals with the effects of collisional friction on the refractive index of an ionised medium, and with the results of taking these into account. The last section discusses the limiting polarisation of wireless waves as observed at the ground.

ÜBERBLICK ÜBER DIE PHYSIK DER HOHEN ATMOSPHÄRE (A Survey of the Physics of the Upper Atmosphere).—J. Bartels. (*E.N.T.*, Special Number, Vol. 10, 1933, 40 pp.).

The full survey, a short version of which was dealt with in February Abstracts, p. 92. A good deal of the later portion is concerned with the ionising or dissociating effect of monochromatic radiation, particularly as treated by Chapman

[Abstracts, 1930, p. 623; 1931, pp. 89 and 607; 1932, p. 27; etc.]. As regards the difference between the ionised layers at heights of 100 and 220 km, this "is not limited merely to the nature of the ionising process. It may be taken that in the upper layer the number of free electrons is nearly as great as the number of positive ions, because few negative ions are formed by the attachment of electrons to neutral atoms or molecules. In the lower layers, on the other hand, there are probably many more ions than electrons. The presence of electrons is indeed shown by the polarisation measurements, and the establishment of double refraction, in connection with electromagnetic waves; but on the other hand the radio measurements prove nothing against the presence of a large number of ions, since as regards the propagation of waves an electron can be replaced by 4×10^4 (ratio of masses of ion and electron) ions. The ion densities demanded by the "dynamo" theory of the variation of the earth's magnetism (10^8 to 10^9/cm^3) are thus not improbable; these ions presumably consist of positive N_2 ions and negative O ions. Since the average life of a free electron varies inversely as the density of the air, it is clear why the height of the lower ionised layer apparently rises at night according to radio measurements."

MESSUNGEN AN DEN KENNELLY-HEAVISIDE-SCHICHTEN NACH EINER KONTINUIERLICH REGISTRIERENDEN METHODE (Measurements on the Kennelly-Heaviside Layers by a Continuously Recording Method).—P. Wolf. (*Hochf:tech. u. Elek:akus.*, Feb., 1933, Vol. 41, pp. 44–53.)

The method was described in an earlier paper (Rukop and Wolf, 1932 Abstracts, pp. 275–276). From the author's summary:—"As results of the measurements, a completely regular direct dependence of the upper KHL on the sun was first established, using an 84-m wave. At sunrise the layer appears at a height of about 500 km, rapidly sinking to the day height of about 230 km.

"After sunset the layer rises slowly, to disappear again at heights of 500 km. At the times of rising and falling of the layer, double refraction phenomena occur. Also temporary small irregularities are noticed in the concentration of the upper layer [thus on p. 49 it is mentioned that at sunrise the height may undergo a transitory increase, and at sunset a transitory decrease. Among other types of irregularity discussed on that page, an occasion is mentioned when the layer rose shortly before midnight to 560 km and then sank to 380 km, where it finally disappeared].

"The lower layer, at about 100 km, is also from time to time reflecting to the 84-m wave. The experiments however only show statistically a dependence on daylight: a regular connection with the sun could not be established with an 84-m wave. No reflection of recordable strength was obtained from the upper layer with a 41-m wave at vertical incidence. The lower layer, however, was at times dense enough to allow reflection at this wavelength. Double refraction at the lower layer was not definitely established. Multiple echoes were less frequent in summer than in winter. Even first-reflection echoes were rare in summer, particularly after midday, and for small transmitting powers they completely vanished."

THE APPLETON-HARTREE FORMULA AND DISPERSION CURVES FOR THE PROPAGATION OF ELECTROMAGNETIC WAVES THROUGH AN IONISED MEDIUM IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD. PART I: CURVES FOR ZERO ABSORPTION.—Mary Taylor. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 245–265.)

Author's abstract:—This paper gives dispersion curves derived from the Appleton-Hartree formula in the case of zero absorption. The value of the magnetic field is taken as that of the earth's field at Slough [Buckinghamshire]. The curves are drawn to show the value of the squares of the indices of refraction and attenuation as functions of the electron density for a series of twelve frequencies, which are chosen to illustrate the various classes of curve and the boundary curves separating the classes and, in the case of frequencies above 1.321 megacycles per second, the various regions of short and ultra-short waves. The derivation and general properties of the Appleton-Hartree formula and the various possible modes of propagation are also discussed. The dispersion curves are classified according to the infinities they contain and a diagram is given to show how the classes of curve holding for any angle of inclination of the direction of propagation to the magnetic field H depend on the ratio of the longitudinal component of H to H itself. The use of the zeros and infinities of the dispersion curves in the interpretation of propagation phenomena is described and a summarising diagram is given, showing how the possible propagation of zero, one, or two basic modes for any frequency depends on the electron density. The polarisation corresponding to each dispersion curve is shown graphically and the general properties of the polarisation of the basic propagation modes are discussed.

THE GENERATION AND RECEPTION OF WIRELESS SIGNALS OF SHORT DURATION [for Investigation of Ionosphere].—J. F. Herd. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 221–234.)

Author's abstract:—In the use of short-duration signals for investigation of the ionosphere, it is convenient to emit the signal pulses at a controlled rate and to receive them on an oscillograph giving temporal discrimination between the arrival of the ground ray and that of subsequent echoes. Simplification of recording technique can be obtained if, at the receiver, an oscillograph of the cathode-ray type is used in conjunction with a time-scale voltage whose rate of recurrence is exactly the same as that of the emitted impulses. The paper describes methods of utilising the common frequency of an a.c. supply network to secure such synchronisation.

The arrangement is first described in connection with ticking-grid circuits at the emitter and as a linear time-base device at the receiver. Alternative linear time bases using mercury-vapour triodes (thyratrons) are then discussed, and these circuits are combined with known means of obtaining a

circular time scale [1932 Abstracts, pp. 535-536: Radio Research Station] to produce a spiral time scale affording wide temporal separation of observed phenomena and more fully utilising the whole oscillograph screen. Lastly an improved method of impulsing the transmitter is described, involving the use of a thyratron as an abrupt switching device.

A Comparison of the Frequency-Change and Group-Retardation Methods of Measuring Ionised-Layer Equivalent Heights.—R. Naismith. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 235–244.)

Author's abstract:—The paper describes a number of experiments designed to test the measurement of the equivalent heights of the ionised layers by the frequency-change and group-retardation methods. Measurements are conducted under as varied conditions as possible. The results appear to confirm the theoretical investigation recorded by Appleton in 1928 [1929 Abstracts, p. 145]. The apparatus used to measure the amount of the frequency change employed in the measurement is described.

Some Long-Distance Transmission Phenomena of Low-Frequency Waves.—E. Yokoyama and I. Tanimura. (*Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 263–270.)

Authors' summary:—"From the results of a series of 24-hour receiving measurements conducted here for more than 2½ years, some interesting phenomena are picked out and discussed. The main points of the conclusions reached are:—(1) the daylight signal strength of Kahuku [17.7 kc/s] is greater than the night signal strength; (2) several successive crevasses of about a two hours' period are observed regularly in the signal strengths of Bolinas and Kahuku during the partial daylight hours."

The first phenomenon is explained on the grounds that transmission between Hawaii and Japan "follows the *skip-type* propagation because of 100 per cent. oversea transmission. The radiated energy . . . propagates with multiple hops and not diffusively, as fully explained in the previous paper [Yokoyama and Namba, Jan. Abstracts, p. 30]. Thus the field strength does not always decrease when the distance of transmission is elongated" and it is supposed that in the daytime the main beam comes down exactly within the receiving area, while at night it is reflected at a higher level and comes down at a more distant region.

The second phenomenon is explained by the change from "metallic" to "dielectric" reflection and *vice versa* (see above reference); "as there exist three apexes for the transmission path between Kahuku and Tokyo and four apexes for that between Bolinas and Tokyo [assuming a layer height of 80 km], it may easily be understood that there appear 3 crevasses in the diurnal field-intensity curve of the former and 4 in that of the latter." Neither phenomenon is ever observable in the case of overland transmission because there the transmission is of the "diffused" type.

Measurements of Ionisation in the Kennelly-Heaviside Layer during the Solar Eclipse of 1932.—J. T. Henderson. (*Canad. Journ. of Res.*, Jan., 1933, Vol. 8, No. 1, pp. 1–14.)

Author's abstract:—"The ionisation of the K.-H. layer was measured by Appleton's method [using the Breit and Tuve 'pulse' technique] during the total solar eclipse of August 31, 1932. In contrast to normal days, a sudden decrease of 58% during the period of optical totality was found. This is shown to be in accord with Appleton's, but not with Chapman's, theory that the cause of lower-layer ionisation is ultra-violet light from the sun. Some measurements were made of the effective height of the Appleton layer, and these are discussed in detail. There is a marked effect at the time of optical totality on this layer also" (*cf.* next abstract). Mention is made of certain inconclusive evidence of a small "particle" (corpuscular) eclipse. Certain blank periods in the days preceding the eclipse, when no echoes on any frequency between 6.0 and 1.77 Mc/s could be obtained, are "very tentatively" explained by heavy absorption in the *D* layer, which might be unusually intensely ionised on these magnetically disturbed days.

Radio Observations on the Upper Ionised Layer of the Atmosphere at the Time of the Total Solar Eclipse of August 31st, 1932.—D. C. Rose. (*Ibid.*, pp. 15–28.)

The station concerned was at Kingston, Ontario, "approximately under the centre of totality for the upper or Appleton layer," whereas the stations concerned in the observations dealt with in the preceding abstract were at Corner Brook, Newfoundland, and Vankleek Hill, Ontario. Here again the "pulse" method was employed. "The results indicate that the ionisation of the upper layer is caused by radiation (presumably ultra-violet light) from the sun. Whether or not this is the sole cause is uncertain because of the time lag in recombination of ions in the layer. A reduction in ionisation of over 30% was noted. A magnetic storm which occurred a few days before the eclipse made the results more difficult to interpret but gave some information of the effect of such a storm on the upper layer. It appeared to cause considerable instability in the layer and a somewhat lower ion content." On the two days after the eclipse "a new phenomenon was noted. At certain times of the day there appeared to be a frequency at which no echo was found, while echoes from the same region appeared at both lower and higher frequencies. When an echo did appear at this so-called reflectionless frequency it was split usually into several components, while echoes at lower and higher frequencies usually consisted of a single clear component. Lack of measurable echoes at a certain frequency might be due to local causes, but no explanation is given for the selective splitting."

Fading and Signal-Strength Measurements taken during the Solar Eclipse of August 31st, 1932.—J. T. Henderson and D. C. Rose. (*Ibid.*, pp. 29–36.)

Authors' abstract:—This paper contains the results of observations on signal strength and

fading, taken during the total solar eclipse of 31st August, 1932, by the Canadian Marconi Company, the Northern Electric Company, the Marine Department of the Canadian Government and l'École Polytechnique, Montreal.

The Canadian Marconi Company at Yamachiche took signal-strength observations on trans-Atlantic and American short-wave stations. The Northern Electric Company measured field strengths in Montreal from the Ottawa station in the broadcast band (600 Kc). The stations of the Marine Department in the Hudson Strait and Hudson Bay regions and also in the Newfoundland and Nova Scotia region took notes on short-wave reception from Ottawa and direction-finding bearings on specified nearby stations. L'École Polytechnique had a receiving station at Rigaud, Quebec.

The results of observations on short waves indicate no effect at the time of the predicted corpuscular eclipse, but a definite night effect at the time of optical totality. Direction-finding stations and observations on the broadcast band report no effect.

ECLIPSE CINEMATOGRAPHY [Technique, and Importance as Aid in Determining Exact Times of Contact and Duration].—S. A. Korff. (*Review Scient. Instr.*, Feb., 1933, Vol. 4, pp. 86–87.)

SOLAR INFLUENCES ON RADIO TRANSMISSION [Survey].—E. V. Appleton. (*World Radio*, 3rd, 10th, 24th Feb. and 10th March, 1933, Vol. 16, pp. 140 and 144, 196 and 198, 265, and 337.)

[AUSTRALIAN] RADIO RESEARCH BOARD: FOURTH ANNUAL REPORT (FOR YEAR ENDED 30TH JUNE, 1932) [Fading: Lateral Deviation of Sky Wave on Broadcasting Frequencies: Directional Properties of Short Horizontal Aerials: Atmospherics, etc.]. (*Journ. of Council for Scientific and Industrial Research, Australia*, Nov., 1932, Vol. 5, No. 4, pp. 247–252.)

Anomalous fading results on broadcast frequencies suggested the presence of lateral deviation of the sky wave. Reception and measurement of the deviation of sky wave were investigated on various types of aerial systems. The method developed depends on simultaneous observation on three suitably spaced systems. Properties of different types of aerial, as regards sky wave reception, were noted—*e.g.*, "a short horizontal antenna was found to have marked directional properties, being rather better in this respect than a loop aerial."

Investigations on atmospherics (*see* also Munro and Huxley, under "Atmospherics") confirmed that each is produced by a "natural transmitter" (*i.e.*, a lightning stroke, "generally occurring in thunderstorms"), all these transmitters operating with the same order of power. "For a given atmospheric, the intensity observed on a receiver of given low-frequency response is to a first approximation proportional to the wavelength to which the receiver is tuned," after allowance has been made for the difference in attenuation on different wavelengths. The sources are of two types: (1) regular, occurring in the same direction at the same time over a definite period of the year ("tropical areas of great thunderstorm activity"), and (2) irregular ("distant sources in directions between *N* and *E*, probably due to thunderstorms over the tropical ocean and islands, and sources within or close to Australia in sub-tropical latitudes and associated with areas of low barometric pressure"). "All the evidence . . . supports the belief that, with a few suitably located cathode-ray direction finders, low pressure areas could be traced as they approached Australia from the India Ocean and the Australian Bight, and in that way considerably earlier information obtained as to their existence than is possible by existing methods depending on barometric readings from land stations and one or two ships at sea."

GENERAL THEORY ON THE PROPAGATION OF RADIO WAVES IN THE IONISED LAYER OF THE UPPER ATMOSPHERE.—S. Namba. (*Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 238–262.)

Abbreviated translation of the Japanese paper dealt with in March Abstracts, p. 149.

SUN SPOTS AND RADIO RECEPTION.—H. T. Stetson. (*Smithsonian Institution*, Washington, Publication 3145, 14 pp. and 2 plates.)

"Reprinted by permission, with change of title and other revision, from the Journal of the Franklin Institute, October, 1930" (*see* Abstracts, 1931, p. 29: *also* 1932, pp. 156 and 408, and below).

PROGRESS IN THE STUDIES OF COSMIC CORRELATIONS WITH RADIO RECEPTION AT THE PERKINS OBSERVATORY [Closer Inverse Correspondence of Radio Reception with Sunspot Numbers—Closer than with Ultra-Violet Radiation: Correlation with Lunar Altitudes].—H. T. Stetson. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 180–181: pub. by Nat. Research Council, Washington.)

SOME COMMON PERIODICITIES IN RADIO TRANSMISSION-PHENOMENA [Solar Rotation Period and Its Prominent Third Harmonic: Lunar Period, with Prominent Second Harmonic suggesting a Kennelly-Heaviside Layer Tidal Effect.]—G. W. Kenrick and G. W. Pickard. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 172–179.)

THE GEOPHYSICAL SIGNIFICANCE OF RADIO MEASUREMENTS OF THE IONISED LAYER [and a Discussion of Bartel's Correlation Methods and Tests for Harmonic Components].—M. A. Tuve: Bartels. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 160–166.)

KENNELLY-HEAVISIDE-LAYER MEASUREMENTS ON THE BYRD ANTARCTIC EXPEDITION, 1929–30.—M. P. Hanson. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 167–172.)

"Summarising the results obtained at the three different seasons [winter, July; early spring, end of August, with sun above horizon for less than an hour at noon; and summer, January, during con-

tinuous sunlight], the observed echo-times have shown virtual reflection-heights ranging between 200 and 800 km.

"On the 83- to 86-m waves, reflection-heights ranged from 200 to 450 km; the 68- and 60-m observations gave virtual heights generally between 250 and 450 km, with some extensions up to 650 km. The 45-m reflection-zones corresponded to virtual heights mostly between 375 and 650 km, while the 34-m echoes—obtained during winter and spring only—ranged from 400 to 800 km. Because of continuously variable virtual heights up to about 800 km and a sudden cessation above this value, it is concluded that this value represents the physical limit of simple reflections covered by these observations."

ON CALCULATIONS OF THE IONISATION IN THE UPPER ATMOSPHERE [Better Agreement between Calculated and Observed Night Increase of Skip Distance by Recognition of Winds and Effect of Earth's Magnetic Field: etc.].—E. O. Hulburt. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 159–160.) *See* also 1932 Abstracts, p. 335.

ON WINDS IN THE UPPER ATMOSPHERE [Meteor-Train Observations agree with Theoretical Inferences: Desirability of Meteor-Train Observations during Magnetic Storms].—E. O. Hulburt. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, p. 124.)

POLARLICHT UND WELTRAUMECHO (The Aurora and World Space Echoes [Suggestion of Long Bands of Particles from the Sun]).—H. Dostal. (*Verh. der deut. Phys. Ges.*, No. 2, Vol. 13, 1932, pp. 17–18.) *See* also January Abstracts, p. 31.

ÜBER DIE ENERGETISCHE BEEINFLUSSUNG DER TROPOSPHÄRE DURCH STRATOSPHÄRISCHE DRUCKSCHWANKUNGEN (On Energy Effects in the Troposphere produced by Pressure Variations in the Stratosphere).—H. Ertel. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 101.)

PROPAGATION D'OSCILLATIONS ÉLECTRIQUES LE LONG D'UN TUBE CONTENANT UN GAZ IONISÉ (The Propagation of Electrical Oscillations along a Tube containing an Ionised Gas).—C. Gutton and M. Chenot. (*Comptes Rendus*, 27th Feb., 1933, Vol. 196, No. 9, pp. 589–591.)

When one of the ends of a long tube, containing a gas at a pressure of the order of a thousandth of a millimetre of mercury, is approached by a valve oscillator of a few metres' wavelength, the tube is illuminated and the luminosity stretches to regions where the field of the oscillator is negligible. In fact, the field may be completely suppressed by enclosing the oscillator in a metal box into which only a short length of the tube penetrates.

Mlle. Chenot has shown (1931 Abstracts, pp. 166 and 261) that if the oscillations are strong enough for the luminous column to reach the far end of the tube, a system of stationary waves is set up. The distances between nodes are much shorter than in the case of stationary waves in a wire: they correspond to a velocity of propagation of only some hundredths of the velocity of light. In the present Note the writers investigate theoretically the motions of the "electrified centres" in such a tube; they assume that the oscillations are weak enough to produce no supplementary ionisation, so that only the *distribution* and not the *number* of electrons (which alone are considered to oscillate, the positive centres being of so much greater mass) is affected. It is found that the propagation of the electronic oscillations has a velocity $V = ked\sqrt{N/m}$: so that the velocity is proportional to the diameter of the tube and the square root of the number of electrons per cm^3. Thus there is no need to bring the action of the positive ions into the explanation of the propagation, for although the assumed conditions (*e.g.*, uniform ionisation along the tube) are not strictly those of the experiments, the low pressure there employed and the consequent diffusion of the electrified centres render the theoretical treatment applicable.

SUR L'ABSORPTION D'ÉNERGIE DANS LES GAZ IONISÉS (The Absorption of Energy in Ionised Gases).—Th. V. Jonescu and Irene Mihul. (*Comptes Rendus*, 6th March, 1933, Vol. 196, No. 10, pp. 682–684.)

Continuation of the work dealt with in February Abstracts, p. 93. The gas was in two tubes, each 5 cm in diameter, one 50 cm and the other 110 cm in length. Current from a dynamo of $2\,000 \times 0.6$ volt-amperes was passed between aluminium electrodes, and was regulated by a kenotron in series. A resonator composed of a single turn of diameter 21 cm was brought into resonance with an oscillator 1 metre away. The tube under examination was inserted in the middle of the turn. Measurements were made in the negative column of the short tube and in the negative and positive columns of the long tube. Wavelengths of 4.40 and 7.17 metres were employed, and the pressures shown in the curves range down to 0.04 mm Hg, being reduced for each gas till current ceased to pass.

The curves show that the absorption of energy is a function of the strength of the current passing through the tube, of the nature and pressure of the gas, of the wavelength and of the length of the tube. In the positive column the absorption takes place for a larger current than in the negative column. The density of ionisation is smaller in the positive column than in the negative. It is not homogeneous in the negative column, but the absorption of energy takes place for well marked values of the current passing. Other results are mentioned.

RADIO COMMUNICATIONS BY MEANS OF VERY SHORT ELECTRIC WAVES.—G. Marconi. (*Marconi Review*, Jan.–Feb., 1933, No. 40, pp. 1–12.)

Second and concluding part of the R.I. paper (*see* April Abstracts, p. 207).

RADIO COMMUNICATIONS BY VERY SHORT ELECTRIC WAVES.—Marconi. (*Nature*, 4th March, 1933, Vol. 131, No. 3305, pp. 292–294.)

A report of the R.I. discourse already dealt with in previous Abstracts. With regard to the Rocca di Papa–Cape Figari tests it is suggested in a footnote that the optical range, taking into account the heights of transmitter and receiver, is 105 miles and not the 72 miles quoted in the discourse.

THE INTERFERENCE PATTERN OF THREE CARRIER WAVES: ERRATUM.—Ladner and Wassell. (*Marconi Review*, Jan.–Feb., 1933, No. 40, p. 26.) *See* April Abstracts, p. 207.

THE SCREENING OF THE MAGNETIC FIELD OF CYLINDRICAL COILS.—Hillers. (*See* under "Subsidiary Apparatus and Materials.")

THE SCATTERING OF LIGHT [and the Effect of Particle Size].—W. D. Bancroft and C. Gurchot. (*Journ. of Physical Chemistry*, No. 10, Vol. 36, 1932, pp. 2575–2587.)

THE RELATION BETWEEN THE RESOLVING POWER OF A SPECTROSCOPE AND THE PRINCIPLE OF UNCERTAINTY.—S. Goldman. (*Journ. Opt. Soc. Am.*, Feb., 1933, Vol. 23, pp. 70–71.)

"... the difference in time along the optical paths of the extreme rays through the prism spectrometer ... is $\Delta t = T(1/U - 1/a)$," where U and a are the group and phase velocities in the prism. "This is the indefiniteness, introduced by the spectroscope, in the time specification of the photons resolved by the prism. Therefore, also in this case $\Delta E \cdot \Delta t = h$."

ON RADIOMETER ACTION AND THE PRESSURE OF RADIATION.—Mary Bell and S. E. Green. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 320–357.)

CONTRIBUTIONS TO THE CALCULATION OF THE VELOCITY OF SPHERICAL WAVES [Raumwellen] IN THE INTERIOR OF THE EARTH.—H. Witte. (Summary in *Physik. Ber.*, 15th Feb., 1933, Vol. 14, No. 4, pp. 321.)

SOME REMARKS ON THE [Japanese] EARTHQUAKE OF 2ND MARCH, 1933.—C. E. Brazier and L. Génaux: Maurain. (*Comptes Rendus*, 6th March, 1933, Vol. 196, No. 10, pp. 716–717.)

Paris observations. Although the waves were of long period (30–40 secs.) and therefore of low acceleration, the amplitudes were the largest ever recorded at Paris.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

SUR UNE ÉPOQUE REMARQUABLE D'ACTIVITÉ SOLAIRE—PREMIÈRE QUINZAINE DE FÉVRIER. (A Noticeable Period of Solar Activity—the First Fortnight in February).—H. Memery: Esclangon. (*Comptes Rendus*, 27th Feb., 1933, Vol. 196, No. 9, pp. 603–605.)

The writer calls attention to sunspot statistics of the years from 1880 to 1933, which (as Esclangon points out in a supplementary Note) tend to show the existence of an *annual* sunspot period: Esclangon remarks that "such a conclusion must be formulated with reserve, for it would lead to the rather surprising consequence of a certain degree of connection between the production of sunspots and the period of revolution of the earth about the sun—a connection which, logically, should be extended to the other planets."

SOME COMMON PERIODICITIES IN RADIO TRANSMISSION-PHENOMENA.—Kenrick and Pickard. (*See* under "Propagation of Waves.")

COSMIC DISTURBANCES OF THE EARTH'S MAGNETIC FIELD AND THEIR INFLUENCE UPON RADIO COMMUNICATION [Comprehensive Survey].—A. E. Kennelly. (*Scientific Monthly*, New York, July, 1932, Vol. 35, pp. 42–56.)

THE RIDDLE OF THE SECULAR VARIATION OF THE EARTH'S MAGNETISM [and the Suggestion of a Magnetised Core rotating with a 480-Years' Period].—A. Schmidt. (*Terr. Mag. and Atmos. Elec.*, No. 3, Vol. 37, 1932, pp. 225–230.)

CONTRIBUTION TO THE STUDY OF MAGNETIC DISTURBANCES.—J. Lévine. (*La Météorologie*, No. 88, 1932, 14 pp.)

A NEW APPARATUS FOR THE MEASUREMENT OF THE EARTH'S MAGNETIC FIELD.—L. F. Bates. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 180–193.)

ATMOSPHERICS IN AUSTRALIA—I. RADIO RESEARCH BOARD, REPORT NO. 5.—G. H. Munro and L. G. H. Huxley. (*Journ. of Council for Scientific and Industrial Research, Australia*, Nov., 1932, Vol. 5, No. 4, pp. 265–266.)

A summary of the Council's *Bulletin No.* 68, on the atmospherics work dealt with in an abstract under "Propagation of Waves." The Bulletin itself (49 pp.) shows that the measurements were made on wavelengths of 3 to 30 km: they are being extended to shorter wavelengths. The possibility is mentioned that in a few instances the source is a dust storm, not a thunderstorm. Section 4 deals with the attenuation of 3 km waves over different distances, as deduced from the atmospherics results, a comparison with the various well-known formulae being made. The method developed of using a vertical aerial for the determination of sense, for a c.-r. direction finder, is described on pp. 25–26.

WORK OF UNITED STATES HYDROGRAPHIC OFFICE IN TERRESTRIAL MAGNETISM AND ELECTRICITY [Locating Thunderstorms by Cathode-Ray Direction Finders].—W. R. Gherardi. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 157–158.)

THEORY OF ELASTIC SYSTEMS VIBRATING UNDER TRANSIENT IMPULSE, WITH AN APPLICATION TO EARTHQUAKE-PROOF BUILDINGS [and to the Effect of Static on Radio Circuits].—Biot. (*See* under "Properties of Circuits.")

A FUNDAMENTAL PROBLEM OF THE MOTION OF AN ELECTRICALLY CHARGED PARTICLE IN COSMIC SPACE.—C. Störmer. (*Zeitschr. f. Astrophysik*, No. 4, Vol. 4, 1932, pp. 290–318.)

Continuation of the work referred to in 1932 Abstracts, p. 299.

THE HORSESHOE AURORA.—E. L. Hill: Störmer. (*Review Scient. Instr.*, Feb., 1933, Vol. 4, p. 65.)

A note on Störmer's recent paper in which he gave his calculations of the orbits traversed by the electrons. "These calculations should have an immediate application in the field of cosmic rays, if these are really high-speed electrons as is so strongly suggested by the recent work of A. H. Compton and his co-workers."

AN AURORAL ARC AT LESS THAN 80 KM HEIGHT ABOVE THE EARTH.—L. Harang and W. Bauer. (*Gerlands Beitr.*, No. 1, Vol. 37, 1932, pp. 109–115.)

Description of the very low aurora referred to in 1932 Abstracts, p. 578. It was filmed at Tromsö and Tennes.

MAGNETISCHE ABLENKUNG DER ULTRASTRAHLEN IN DER WILSONKAMMER (Magnetic Deviation of Cosmic Rays in a Wilson Cloud Chamber).—P. Kunze. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 9/10, pp. 559–572.)

Author's summary:—A Wilson cloud chamber is placed in the magnetic field of an air-core current coil, working with 1 000 A and 500 V. The investigation of the magnetic spectrum of the cosmic ray particles gives the following result: The particles consist not only of electrons but of positively charged particles. The particles increase in frequency as the region of small energies is approached; energies above 10^9 volts occur relatively seldom. With the great accuracy of measurement here attained, energies up to 10^{10} volts can still be measured; the most rapid corpuscles, if they are electrons, have energies of more than 9 200 million volts. No upper limit to particle energy has been found. Discussion of multiple tracks is reserved for a forthcoming paper.

DER ENERGIESTROM DER ULTRASTRAHLUNG (The Energy Current of Cosmic Radiation).—E. Regener. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 9/10, pp. 666–669.)

Author's summary:—The total energy falling as cosmic radiation on the outside of the earth's atmosphere is found to be 3.53×10^{-3} ergs per cm^2 per sec. This gives 2.4×10^6 horse-power per hour over the whole surface. This energy current is very close in value to that coming as light and heat from the fixed stars. The effect of this fact on the temperature of interstellar space is discussed.

THE SUN AND COSMIC RAYS.—R. A. Millikan and H. V. Neher. (*Phys. Review*, 1st Feb., 1933, Series 2, Vol. 43, No. 3, p. 211.)

Abstract only. New experiments with instruments of increased sensitiveness have been made both at low and at high altitudes. These reveal no trace of a direct solar influence. If any such influence exists it is shown to be so minute in comparison with the indirect influences which produce changes in the atmospheric blanket as to be negligible in comparison.

THE LATITUDE EFFECT ON SECONDARY ELECTRONS DUE TO COSMIC RAYS.—R. M. Langer. (*Phys. Review*, 1st Feb., 1933, Series 2, Vol. 43, No. 3, p. 215.)

Abstract only. The writer concludes "that for any reasonable value of the parameters involved, no latitude effect as large as three per cent is to be expected for electrons generated in the atmosphere. The conclusion holds for measurements made at altitudes up to 20 000 ft at least."

SOME NEW COINCIDENCE MEASUREMENTS ON THE COSMIC RADIATION.—B. Sparks and W. Pickering. (*Phys. Review*, 1st Feb., 1933, Series 2, Vol. 43, No. 3, p. 214: abstract only.)

A MECHANISM OF ACQUIREMENT OF COSMIC-RAY ENERGIES BY ELECTRONS.—W. F. G. Swann. (*Phys. Review*, 15th Feb., 1933, Series 2, Vol. 43, No. 4, pp. 217–220.)

The mechanism here suggested is the growth of stellar magnetic fields such as occur in sunspots; the writer finds that, on Faraday's law of electromagnetic induction, these can give rise to electric fields capable of giving electrons energies corresponding to 10^{10} volts. Spots such as occur on the sun may give energies up to 10^9 volts and the writer suggests that "electrons projected from such spots may play a part in auroral phenomena. For cosmic rays one must, however, probably look to the stars for the necessary conditions." *Cf.* Gunn, April Abstracts, p. 209.

TEMPERATURE EFFECT AND ITS ELIMINATION IN GEIGER-MÜLLER TUBE COUNTERS.—L. F. Curtis. (*Bur. of Stds. Journ. of Res.*, Feb., 1933, Vol. 10, No. 2, pp. 229–232.)

CONTRIBUTION TO THE STUDY OF THE FULMINATING MATTER: EVALUATION OF THE CONSTANT RATIO BETWEEN THE FINAL AND INITIAL VOLUMES IN THE PROGRESSIVE DECOMPOSITION AT ATMOSPHERIC PRESSURE WHEN THE FINAL TEMPERATURE IS IDENTICAL WITH THE INITIAL TEMPERATURE.—E. Mathias. (*Comptes Rendus*, 13th Feb., 1933, Vol. 196, No. 7, pp. 455–458.)

EXPERIMENTAL STUDIES ON THE PROPAGATION OF LIGHTNING SURGES ON THE 154 kV TOKYO LINE OF THE NIPPON ELECTRIC POWER COMPANY.—K. Kasai. (Summary in *Physik. Ber.*, 15th Feb., 1933, Vol. 14, No. 4, p. 294.)

ÜBER BLITZSCHUTZ DURCH "FERNBLITZABLEITER" (Protection against Lightning by the "Distant Lightning Conductor" [and the Calculation of the Area protected by a Vertical Well-Earthed Rod of given Height]).—B. Walter. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 14, 1933, pp. 118–126.)

THE INFLUENCE OF ATMOSPHERIC SUSPENSOIDS UPON THE EARTH'S ELECTRIC FIELD AS INDICATED BY OBSERVATIONS AT KEW OBSERVATORY.—H. L. Wright. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 152–171.)

Among the various results, it is found that conductivity decreases as the number of nuclei increases, owing to the fact that conductivity is preponderantly due to small ions and that the chance of survival of the small ions decreases with the number of nuclei.

SLOW-MOVING IONS IN THE ATMOSPHERE.—G. R. Wait and O. W. Torreson. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, pp. 182–187: pub. by Nat. Research Council, Washington.)

THE EFFECTS ON HUMAN BEINGS OF ATMOSPHERIC ELECTRICAL PHENOMENA AND METEOROLOGICAL INFLUENCES.—U. Chorus and F. Levi. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 81.)

PROPERTIES OF CIRCUITS

SKINEFFEKT IN EINEM GESCHICHTETEN KREISZYLINDER (Skin Effect in a Stratified Cylinder of Circular Section).—M. J. O. Strutt. (*Hochf:tech. u. Elek:akus.*, Feb., 1933, Vol. 41, No. 2, pp. 62–63.)

It is common practice in high-frequency engineering to employ "stratified cylinders" (*e.g.*, silvered copper wires or tubes) to reduce the a.c. resistance below that given by the plain copper wire or tube. The present paper gives a quantitative examination of the behaviour of such a composite conductor with a solid core, formulae being obtained which can be applied to any special case. Although their numerical working-out involves a good deal of labour, it is shown by an example that a rough idea can readily be obtained. The example taken is for a copper cylinder covered by a layer of iron: the frequency is 50 kc/s. In this case, where the outer layer is of inferior conductivity but of great permeability, the conditions are opposite to those usually obtaining, and the results are naturally also opposite: the ratio of a.c. resistance to d.c. resistance is shown to be about four times as great as for a plain copper conductor. For a previous paper by the same writer on the theoretical treatment of skin effect, *see* 1931 Abstracts, p. 608.

A PRACTICAL ANALYSIS OF PARALLEL RESONANCE [with Applications to the Adjustment of Radio Apparatus].—R. Lee. (*Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 271–281.)

"Vector diagrams are developed for various conditions of tuning parallel circuits, and from the geometry of the diagrams mathematical relations are derived. These relations are then plotted for use in tuning operations. Two examples are given of the practical application of the analysis": thus although it is customary to tune an amplifier for minimum plate current, it is often found that full output cannot be obtained unless the tuning is slightly off this point: the conclusion is then drawn that the amplifier must be "detuned" in order to deliver full output, whereas actually it is changed from the maximum impedance to the unity power factor condition. This situation is avoided if the amplifier is condenser-tuned, so that this method has the advantage of simplicity of adjustment.

The second example relates to the termination of transmission lines, where circuits are sometimes used which must be adjusted for unity power factor, "a difficult matter unless the relations set forth above are used."

ON THE THEORY OF OSCILLATORY CONDENSER DISCHARGES.—J. Thomson. (*Phil. Mag.*, March, 1933, Series 7, Vol. 15, No. 99, pp. 682–706.)

The writer investigates theoretically and experimentally "the sequence of events which follow the breakdown of the insulation of a small air-gap in parallel with a condenser which is charged to a high potential," and concludes that "by assuming $V_0 = Le^{-kt} + Me^{kt}$ as the time-equation for the potential across a discharge, the typical oscillating discharge characteristics may be obtained."

THEORY OF ELASTIC SYSTEMS VIBRATING UNDER TRANSIENT IMPULSE, WITH AN APPLICATION TO EARTHQUAKE-PROOF BUILDINGS [and to the Effect of Static on Radio Circuits].—M. Biot. (*Proc. Nat. Acad. Sci.*, Feb., 1933, Vol. 19, pp. 262–268.)

If a sudden external force $f(x)$ acts on a one-dimensional continuous elastic system without damping, the amplitude of the resulting motion is composed of a series of oscillations each of which has an amplitude equal to twice the corresponding term of the statical deformation $y = \Sigma \frac{C_i}{\omega_i^2} y_i$. If the forces are varying, of the type $f(x)\psi(t)$, starting their action at the origin of time and keeping on during a finite time T, the following theorem is arrived at:—When a transient impulse acts upon an undamped elastic system, the final motion results from the superposition of free oscillations each of which has an amplitude equal to the corresponding term $C_i y_i/\omega_i^2$ of the statical deformation y, multiplied by the value of the "reduced spectral intensity" for the corresponding frequency. The advantage of this theorem is that for the calculation of the motion it replaces a complicated impulse by a spectral distribution which is always an analytical function of the frequency. The writer then generalises the theorem to the case of damping, and finally applies it to evaluate the effectiveness of the so-called "elastic first floor" in earthquake-proof buildings.

A NEW ANALOGY BETWEEN MECHANICAL AND ELECTRICAL SYSTEMS.—F. A. Firestone. (*Journ. Acoust. Soc. Am.*, No. 1, Part I, Vol. 4, 1932, p. 5: summary only.)

SUR LES RÉGIMES TRANSITOIRES (Transient Régimes [in Viscous Liquids]).—E. Crausse and J. Baubiac. (*Comptes Rendus*, 27th Feb., 1933, Vol. 196, No. 9, pp. 602–603.)

EINIGE ELEKTRISCHE OSCILLATOREN SPEZIELLER FORM (Some Electrical Oscillators of Special Shape [Forks with Prongs of Different Length, with Prongs at Right Angles, etc.]). —K. F. Lindman. (Short summary in *Physik. Ber.*, 15th Jan., 1933, Vol. 14, No. 2, p. 150.)

TRANSMISSION

BARKHAUSEN - KURZ - SCHWINGUNGEN; NEUE GESICHTSPUNKTE (New Ideas on the Barkhausen-Kurz Oscillations).—W. Orgel. (*Hochf:tech. u. Elek:akus.*, Feb., 1933, Vol. 41, pp. 56–61.)

A consideration of the results of previous workers leads the writer to reject the usual theory that the oscillations are due to the swinging to-and-fro action imposed on the electrons by a retarding field. Thus as regards the $\lambda^2 E_g = \text{const.}$ relation, which distinguishes the B.-K. oscillations from retroactively produced oscillations, he remarks that not enough recognition has been given to the fact that this relation also holds good for certain other methods of generation whose mechanism is still uncertain: for instance, the Whiddington oscillations (500 m) and the magnetron oscillations (200-2.6 cm). He considers that all these types of oscillation are only special cases of B.-K. type, and the obvious conclusion is that the absence of any retarding field in the Whiddington circuit makes the orthodox explanation invalid for all the types.

Other phenomena involved in B.-K. oscillations, regarding which the writer collects and compares the results of other workers, are the behaviour of the anode current (section I 1) and the need or otherwise of an external Lecher system (section II 1). He arrives at the conclusion that the surface of the grid is the main seat of oscillation production (section II 2), and in the next section he discusses the important part played, in determining the wavelength, by the electrical field at the surface of the grid: a part at least as important as that played by the electron velocity. Thus he considers the fact that B.-K. oscillations do not give such short wavelengths as magnetron oscillations is explained as follows: in the former case the important radiation points of the grid surface lie in the mid-plane of the grid, between each pair of grid wires, where (as shown in Fig. 8) the field strengths are small. They are controlled not only by the grid potential but also by the anode potential, so that the latter as well as the former would be expected to affect the wavelength: this has been shown to be the case by Scheibe.

The final section deals with energy considerations. In the B.-K. oscillations both the radiation from the grid surface and the anode current are energy consumers, so that the whole process requires a supply of energy. In the B.-K. case it is the grid current which "drives the mechanism": in the magnetron, the anode current. The loading of the grid current at the onset of oscillation results in a fall in the current: the product of this current drop and the grid potential is the total power expended. The radiated power is given by subtracting the product of the square of the anode current and the total anode circuit resistance. The case of the Whiddington oscillations is also touched on.

[Ultra-] SHORT WAVE OSCILLATION: PRODUCTION OF ELECTRONIC OSCILLATIONS—METHODS OF USING THE MAGNETRON SHORT WAVE OSCILLATOR [and a Comparison between Electronic and Dynatron Oscillations].—E. C. S. Megaw: General Electric Company. (*Electrician*, 6th Jan., 1933, Vol. 110, No. 2849, p. 11.)

A summary of two I.E.E. papers. The following are among the points quoted from the second paper:—The general expression for the time of transit (in electronic oscillations) is given, and hence expressions for the wavelength in terms of magnetic field strength are obtained for zero and saturated space-charge conditions. The wavelength is found to be about 36% greater in the latter case. It is shown that initial electron velocity causes an appreciable reduction in wavelength in normal cases. The effect of magnetic field on space charge is considered and is found to lead to a small, possibly negligible [experimental results showed it to be negligible] increase in wavelength. This result has been previously stated by Hull, but Hull's deduction that the electrons travel in circular orbits round the cathode is disputed.

An attempt to provide a simplified theoretical explanation of the "dynatron" characteristics of a split-anode magnetron leads to a false result; from this it is concluded that no theory will provide an explanation which does not take into account the non-uniformity of the electric fields in the two halves of the valve. The general shape of the static characteristics is indicated by means of Habann's theory, which is, however, not capable of giving proof of the existence of negative resistance in the case of a symmetrically oscillatory circuit, which is the case considered here. A qualitative explanation of the occurrence of negative resistance, *i.e.*, of the greater fraction of the anode current reaching the lower-potential anode segment, is given.

The existence of an optimum field angle differing from zero is found to be due to the resultant spiral motion of the electrons balancing out the effect of cathode potential-drop for electrons arriving at part of the anode surface in such a way as to increase the number of oscillating electrons. By making use of an internal resonance effect and suitably adjusting the field angle, an output of the order of 1.5 W was obtained at a wavelength of 24 cm.

Dynatron oscillations down to about 35 cm, distinct from both the electronic and simple dynatron oscillations, can be obtained in a split-anode magnetron by tilting the magnetic field. As regards the simple dynatron oscillations, it is found that their energy begins to fall off rapidly at a wavelength about 4 times the electronic oscillation wavelength corresponding to the anode voltage used. This leads to a formula for the wavelength limit for dynatron oscillations.

It is found that during oscillation the anode current may exceed the original total emission. This is probably due to bombardment of the filament by electrons which return to it with considerable velocity: the effect is being further investigated. By taking steps to reduce it, it has been possible to obtain 60 W from a relatively small valve at about 2 m wavelength. The shortest

wavelength obtained by dynatron oscillations was about 30 cm, when the power obtainable was about 0.1 w. It is concluded that below about 50 cm electronic oscillations give the greater output.

OSCILLAZIONI ELETTRONICHE (Electron [Ultra-Short-Wave] Oscillations).—A. Rostagni. (*La Ricerca Scientifica*, 15th–31st Dec., 1932, Vol. 2, No. 11/12, pp. 439–440.) *See* letter to *Nature*, January Abstracts, p. 37.

LOW POWER RADIO TRANSMITTERS FOR BROADCASTING.—A. W. Kishpaugh and R. E. Coram: Western Electric Company. (*Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 212–227.)

Authors' summary:—This paper discusses the place of low-powered installations in the existing radio broadcast system, and the importance of apparatus for such stations meeting the present-day requirements pertaining to frequency stability, modulation capability, fidelity, and radio-frequency harmonics. The characteristics and more interesting features of a new line of transmitters covering the range of output from 100 to 1 000 watts are described. The basic unit is a 100-watt transmitter employing grid-bias modulation which is novel in so far as American broadcast practice is concerned. Outputs of 250, 500, and 1 000 watts are obtained through the use of a supplementary amplifier unit equipped with tubes of appropriate capacity. Radiation-cooled tubes are used throughout, and both units are self-contained, being operated direct from an alternating-current supply without the use of rotating machinery. Mechanically the units are novel in that the housings are of a cabinet form with doors which allow complete access from the front for adjustment and maintenance.

B. B. C. LONG-WAVE STATION [using "Series Modulation"]. (*Electrician*, 20th Jan., 1933, Vol. 110, No. 2851, p. 63.)

Outline of the high-power transmitter, to be installed at Droitwich for the National long-wave service, referred to in April Abstracts, p. 211. The "series modulation system" is described: the modulator and the modulated power stage are placed in series across a constant voltage supply, and the grid potential of the modulator is so adjusted that the total voltage is divided between the two units: control of the modulator grid thus produces a highly linear modulation of the amplifier stage, without the use of an iron-cored choke or transformer. In this way the stages of modulated amplification can be reduced to one, which reduces the amount of harmonic distortion.

MODULATION BY TWO-GRID VALVES.—Lorenz Company: RCA. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, pp. 34: 35.)

In the Lorenz patent, the carrier frequency is applied to the control grids of two double-grid valves in push-pull: one space-charge grid is left unmodulated, the other is modulated, the variations of the space charge producing corresponding changes in the slope of the characteristic. In the RCA patent the screen grid of the generating valve is modulated, and the load on the h.t. generator remains constant.

CIRCUIT FOR MODULATION BY GRID DIRECT CURRENT.—Telefunken Company: Buschbeck. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 37.) *See* Fig. 14.

CRYSTAL-CONTROLLED TRANSMITTER WITH VARIABLE WAVELENGTH.—Telefunken Company. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 36.)

FREQUENCY STABILISATION BY COUPLING THE GRIDS OF PUSH-PULL CIRCUIT THROUGH A QUARTZ CRYSTAL.—Elektroswias, Leningrad. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 38.)

LINE-CONTROLLED SYNCHRONISATION OF COMMON-WAVE TRANSMITTERS.—Runge. (*See* under "Stations, Design and Operation.")

THE REQUIRED MINIMUM FREQUENCY SEPARATION BETWEEN CARRIER WAVES OF BROADCAST STATIONS.—Eckersley. (*See* under "Stations, Design and Operation.")

DIMINUTION OF FADING BY ALTERNATING THE TRANSMITTED WAVE BETWEEN TWO NEIGHBOURING WAVELENGTHS.—USSR Electrot. Association. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 39.)

STRINGENT TEST FOR PHOTOELECTRIC CELL [Half-Mile Optical Link in Broadcast Transmission]. (*Engineer*, 10th Feb., 1933, Vol. 155, No. 4022, p. 143.)

"A stringent test for the photoelectric 'eye' was carried out in New York on January 20th, when a woman singer's voice modulated a beam of light half a mile in length, extending from one New York skyscraper to another. The beam actuated a photoelectric cell which, in turn, modulated the broadcast carrier wave. The transmission was duplicated over the ordinary line, the engineers being able to switch from one to the other method without notifying listeners, who were unable to tell which method was being used at any given time." For the use of a modulated light-ray from an airship as a link in broadcast transmission, *see* February Abstracts, p. 99, bottom of left-hand column.

SUR LES COURANTS DE HAUTE FRÉQUENCE PRODUITS PAR LES MAGNÉTOS À HAUTE TENSION (The H.F. Currents produced by H.T. Magnetos).—J. Jaffray. (*Comptes Rendus*, 27th Feb. 1933, Vol. 196, No. 9, pp. 609–610.)

Continuation of the work dealt with in 1932 Abstracts, p. 458. The wavelengths found with different types of magneto and under different circuit conditions range from 24.5 to 49.0 metres.

RECEPTION

EIN GERÄT ZUM MESSEN DES FREQUENZSPEKTRUMS VON RUNDFUNKSTÖRERN (An Apparatus for Measuring the [Radio-] Frequency Spectrum of Sources of Interference with Broadcast Reception).—W. Wild: Siemens and Halske. (*E.T.Z.*, 16th and 23rd Feb., 1933, Vol. 54, Nos. 7 and 8, pp. 149–152 and 172–174.)

A paper on the apparatus developed in connection with the VDE Commission on Broadcast Interference. The writer remarks: "It might appear that a knowledge of the purely high-frequency spectrum [of a source of man-made interference] would have only an academic interest and could not be translated into information concerning the audio-frequency interference which results in practice after demodulation. But this is not so: the case of practical interest is always one in which the interfering wave falls on a receiver tuned to a definite carrier wave, and it is the accidental phase condition between the already present carrier wave and the interfering wave filtered by the tuning circuits which determines the amount of interference. The latter is greatest when the interfering wave, owing to similarity or opposition of phase, can superpose its full amplitude on the carrier. . . . For a constant sharpness of tuning of the filter elements there is an exact proportionality between the effective value of the a.f. interfering voltage in a receiver and the measured effective radio-frequency." He goes on to point out that for uniform noises, such as those due to electric motors, the effective values of a.f. voltage are a good measure of the strength of interference as observed by the ear; whereas for clicks, crackles, etc., the time-factor of the ear comes into the question and has to be allowed for by the use of a special impulse-measuring circuit.

He then describes the Siemens and Halske mains-driven equipment, based on the above considerations, for testing a source of interference such as a vacuum cleaner, a hot-air blower, or a medical apparatus. It consists of an input circuit (including input filter, "excitation" circuit, and sensitivity regulator); a 4-valve aperiodic r.f. amplifier; a "main filter" circuit with one valve in dynatron connection, followed by a 2-valve aperiodic r.f. amplifier; a r.f. impulse-measuring circuit and a r.f. valve voltmeter, with change-over switch. The actual procedure of a test is described in the last paragraph on pp. 151–152, and some actual examples are illustrated by curves in the second instalment of the paper.

THE H.F. CURRENTS PRODUCED BY H.T. MAGNETOS.—Jaffray. (*See* under "Transmission.")

GASEOUS DISCHARGE TUBES FOR RADIO RECEIVER USE [as Visual Tuning Indicator with or without "Noise Gate"].—J. F. Dreyer: Senauke. (*Electronics*, Feb., 1933, pp. 40–42.)

Especially for superheterodyne receivers. "The gaseous discharge tube provided with a long cathode, a short anode and an auxiliary electrode was devised by Professor A. Senauke of New York University, to be applied to AVC receivers to serve as a visual tuning indicator. . . . Recently, experiments have been under way by Professor Senauke and the writer, to utilise this type of tuning indicator for a noise gate as well. The addition of a fourth electrode and certain circuit changes give promise of doing this, even better than the present methods employing vacuum tubes." The fourth electrode is insulated to a point about $\frac{1}{2}$" above the lower ends of the other electrodes, and when the visible discharge from the long cathode has climbed to the exposed part of the fourth electrode an additional discharge develops which is made to reduce the bias of the a.f. valve, allowing the signal to be amplified further and reproduced in the loud speaker.

IMPROVEMENT TO AUTOMATIC VOLUME CONTROL, TO AVOID HISS ON TUNING TO A BLANK CHANNEL. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 36.)

ADDING AUTOMATIC VOLUME CONTROL TO THE MONODIAL.—W. T. Cocking. (*Wireless World*, 17th March and 24th March, 1933, Vol. 32, pp. 208–210 and 224–227.)

An article dealing with the theoretical considerations underlying the addition of automatic volume control to the receiver described in 1932 Abstracts, p. 345. Practical details for making the necessary alterations to the receiver are also given.

GLOW-DISCHARGE TUBE BETWEEN GRID AND ANODE OF REACTION AUDION TO PREVENT ADJUSTMENT BEYOND OSCILLATION THRESHOLD.—A. J. M. Hinrichsen. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 38.)

THE WESTECTOR.—Westinghouse Brake & Saxby Signal Company. (*Wireless World*, 3rd March, 1933, Vol. 32, pp. 173–174.)

A short description of the new copper-oxide rectifiers for r.f. currents. Inputs up to 36 volts peak can be handled and a maximum current of 0.25 mA passed in the case of half-wave types. These figures are, of course, doubled for corresponding full-wave types. The rectifiers are intended to replace the thermionic diode, but as neither electrode need be at earth potential modified circuits become permissible. *See* also Grondahl and Place, January Abstracts, p. 39.

NEW BATTERY OUTPUT STAGE: CLASS B AMPLIFICATION: THE LATEST DEVELOPMENT.—F. M. Walker. (*Wireless World*, 17th March, 1933, Vol. 32, pp. 200–202.)

Ordinary push-pull is uneconomical for battery sets and quiescent push-pull was developed to overcome this disadvantage (March Abstracts, pp. 156 and 156–157). This system, however, retains the disability of other output systems: the available power to the loud speaker is limited by the fact that, in the interests of good quality, no grid current must be allowed to flow. The system known in America as "class B amplification" is free from this disability, and battery sets using this system can provide an undistorted output of 2 watts or more with an anode current consumption well within the capacity of quite small h.t. batteries.

The writer describes this system and the special "class B" valve (with "two complete sets of valve elements enclosed in one bulb, separate leads being provided for each anode and grid, the filament connections being common") made by Messrs. Cossor for this purpose. *See* also "New Amplifiers . . ." under "Valves and Thermionics."

MAXIMUM OUTPUT, EFFICIENCY, AND OPTIMUM EXTERNAL RESISTANCE OF OUTPUT VALVES [for Class A and Class B Amplification].—Urtel. (*See* under "Acoustics and Audio-frequencies.")

SUPERHETERODYNE RECEIVER WITH MAGNETOSTRICTIVE COUPLING IN I.F. CIRCUIT TO INCREASE SELECTIVITY.—USSR Electrot. Association, Moscow. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 38.)

See Fig. 19, where "1" represents the magnetostrictive coupling and "2" a magnetic compensation coil for neutralising purposes.

THE FERROCART III.—W. T. Cocking. (*Wireless World*, 24th February and 3rd March, 1933, Vol. 32, pp. 146–148 and 169–172.)

A three-valve a.c. mains-driven receiver for the amateur constructor, using the special iron-cored tuning coils ("Ferrocart") referred to in January Abstracts, p. 39, r.-h. column.

THE MIDGET UNIVERSAL MAINS SET.—Keith Henney. (*Wireless World*, 24th March, 1933, Vol. 32, pp. 218–220.)

Details are given of a type of mains-driven receiver now in vogue in America in which the principal feature is compactness, the whole instrument, including loud speaker, being no larger than the latest type of G.P.O. desk telephone. Another feature is that these midget sets are suitable for plugging-in to either a.c. or d.c. mains without alteration.

RECEIVER FOR ULTRA-SHORT WAVES, USING SPLIT-ANODE MAGNETRON.—Int. Gen. Elec. Company. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 39.) *See* Fig. 24.

METHOD OF DEMODULATING A FREQUENCY-MODULATED WAVE.—RCA. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 39.)

THE USE OF URANIUM DIOXIDE AS A SERIES RESISTANCE FOR IRON BARRETTERS.—Meyer. (*See* abstract under "Subsidiary Apparatus and Materials.")

AERIALS AND AERIAL SYSTEMS

A 267-METRE TOWER AS RADIO AERIAL. (*Zeitschr. V.D.I.*, 11th Feb., 1933, Vol. 77, No. 6, p. 159.)

Of galvanised steel, resting on a double-cone insulator and supported at 112 m by eight steel-wire-rope stays in insulated sections. At each corner of the tower runs an aluminium wire, for the sake of increased conductivity.

AN ANTI-FADING AERIAL CONSISTING OF A WIRE WOUND INTO A SPIRAL.—SFR. (Summary of French Patent in *Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 224.)

To nullify polarisation fading, the wire is wound with a pitch equal to λ on an equilateral prism of side-length $\lambda/2 \cdot \cos 30°$. The axis of the helix must lie in the direction of propagation of the signal, and the total length of the wire must be 2λ. Several such aerials may be combined to increase the directional effect.

AERIAL AND REFLECTOR SYSTEM FOR ULTRA-SHORT WAVES.—RCA. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 36.) *See* Fig. 9.

MECHANICAL VIBRATIONS IN TRANSMISSION LINES.—C. D. Niven. (*Canad. Journ. of Res.*, No. 1, Vol. 7, 1932, pp. 95–102.)

SWEDISH TESTS ON IMPREGNATING PROCESSES FOR WOODEN MASTS. (*E.T.Z.*, 16th March, 1933, Vol. 54, No. 11, pp. 261–262.)

VALVES AND THERMIONICS

DER VERLAUF DES ELEKTRISCHEN FELDES IN ELEKTRONENRÖHREN, GEMESSEN IM ELEKTROLYTISCHEN TROG (The Course of the Electrical Field in Electronic Valves, measured in the Electrolytic Trough).—H. Barkhausen and J. von Brück. (*E.T.Z.*, 23rd Feb., 1933, Vol. 54, No. 8, pp. 175–177.)

Extension of the method, already applied to the study of the field distribution of a dipole aerial and to an investigation of the influence of a power line on a communication line, to the field in a triode valve with plane electrodes. *Cf.* McArthur, Abstracts, 1932, p. 475; also Groszkowski, 1929, pp. 391–392.

ÜBER DIE BEEINFLUSSUNG DER ELEKTRONENBAHN DURCH DAS HEIZSTROMFELD VON GLÜHKATHODEN (On the Influence of the Magnetic Field of Filament Currents on the Electron Path).—F. Hamacher. (*Archiv f. Elektrot.*, 14th Feb., 1933, Vol. 27, No. 2, pp. 121–124.)

A simple case of lateral displacement of electrons from a filament in the presence of an external magnetic field is theoretically and experimentally investigated.

NEW AMPLIFIERS, DETECTORS AND RECTIFIERS [Multifilamentary Cathodes: Electron Coupling: Class B: Diode-Pentode, etc.]. (*Electronics*, Feb., 1933, pp. 35 and 55.)

"Nearly a score of new tubes was formally introduced to the industry during the first few weeks of the new year. Many of these tubes offered distinct possibilities to receiver engineers with imagination, others pushed forward the frontier (at present somewhat restricted) of high quality reception, and still others seem merely to complicate an already complex picture." Among valves whose data are given are types 53 and 79, complete class B amplifiers "under one glass top" (*cf.* Walker, under "Reception"); the 2A3 power amplifier triode with multifilamentary cathode, for

the "acme of fidelity," having the high transconductance of 5 500 micromhos and the low resistance of less than 1 000 ohms, and giving 3·5 w, or 15 w in push-pull; the 2B7 and 6B7 diode-pentodes; and the 6A7 electron-coupled detector-oscillator.

SPECIAL TWO-SYSTEM VALVE FOR CLASS B AMPLIFICATION.—A. C. Cossor Ltd. (*See* abstract under "Reception"—Walker.)

THE SCREENED H.F. PENTODE.—T. E. Goldup. (*Wireless World*, 24th March, 1933, Vol. 32, pp. 221–222.)

It has long been known that the ordinary screen-grid valve is handicapped by a secondary electron effect which introduces a kink in the characteristic and thus limits its signal-handling capacity. In the screened r.f. pentode and the variable-mu pentode described in this article this disability is avoided, and the substitution of the new valves for the corresponding s.g. tetrodes, in both straight sets and superheterodynes, will result in considerable improvement in stage gain and stability.

THERMIONIC TUBES IN WHICH GRID- AND ANODE-SECTIONS, IN PLANE PERPENDICULAR TO CATHODE, FORM SPIRALS ONE WITHIN THE OTHER.—(Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 34.). *See* Fig. 2.

NEW DEVELOPMENTS IN FILAMENTLESS TUBES.—A. Hund. (Summary in *Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 182–183.) *See* also April Abstracts, p. 215.

ELECTRONIC EMISSION FROM COLD METALS.—J. E. Henderson. (Summary in *Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 184–185.)

See also 1932 Abstracts, p. 588. "The velocity distribution shows that the electron condition within a metal is very different than ordinarily supposed. Electrons within the metal tested, which was tungsten, must be regarded as having energies ranging effectively up to forty electron volts rather than a few hundredths of a volt which they would have if in kinetic equilibrium with the molecules of the metal. In addition, the most probable value of the energy is very close to the maximum energy observed."

DIRECTIONAL WIRELESS

THE ELIMINATION OF NIGHT-COURSE VARIATIONS IN RADIO RANGE-BEACONS [by Replacing the Crossed Loops by Two Vertical Towers, giving No Horizontally Polarised Components].—N. G. Kear. (*Trans. American Geophysical Union*, 13th Annual Meeting, 1932, p. 154.)

AUTOMATIC CORRECTION OF ERRORS IN DIRECTION FINDING.—Telefunken Company: Leib. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 224.)

ULTRA-SHORT-WAVE GUIDING BEAM WITH INTERLOCKING SIGNALS.—Telefunken Company; Ilberg. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 37.)

Using two dipoles with a common reflector, each dipole being connected alternately to the transmitter.

CIRCUIT FOR DIRECT-READING DIRECTION FINDER.—M. Dieckmann and F. Berndorfer. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 35.)

For a previous patent and back reference, *see* March Abstracts, p. 162.

DIRECT-READING DIRECTION FINDER.—I. T. and T. Laboratories. (*See* abstract under "Miscellaneous.")

ACOUSTICS AND AUDIO-FREQUENCIES

MAXIMALE LEISTUNG, WIRKUNGSGRAD UND OPTIMALER AUSSENWIDERSTAND VON ENDRÖHREN (Maximum Output, Efficiency, and Optimum External Resistance of Output Valves [for Class A and Class B Amplification]).—R. Urtel. (*Telefunken-Zeit.*, Dec., 1932, Vol. 13, No. 62, pp. 28–44.)

Author's summary:—(*a*) It is shown that the supposed differences regarding matching and output conditions between triodes controlled so as to avoid grid current, triodes controlled into the positive grid potential region, and pentodes, all disappear if the deductions are based not on the ordinary value of internal resistance which determines the amplification (and is here denoted by R_{iV}) but on a new value of internal resistance which determines the output power (and is here represented by R_{iL}) and which corresponds to the reciprocal of the slope of the straight line defining the limit of the useful zone of the e_a/i_a family of curves [*see* Figs. 37*a* and *b*, from which it is seen that $R_{iL} = 1/\tan\alpha$, where α is the slope of the line drawn through the lower ends of the straight parts of the characteristics just where they begin to bend down]. The triode controlled so as to avoid grid current then appears as a special case ($R_{iL} = R_{iV}$).

Pentodes, and triodes controlled in the region of grid current, show a close relationship. Their superiority over the triode without grid current is connected with small values for R_{iL}, which in both cases are due to current-transference effects involving a supply of auxiliary energy—in the case of the pentode in the form of d.c. to the screen grid, in the case of the triode in the form of a.c. to the control grid. [In a foot-note the writer points out that the recent demand for pentodes with low internal resistance has nothing to do with the above, being merely a desire for low values of R_{iV} in connection with the frequency characteristic of the loud speaker.]

(*b*) The output and efficiency of an output valve improve with smaller R_{iL} and greater d.c. anode potential E_a for a given maximum permissible anode load $N_{V\,max.}$. To combine these data of an output valve a dimensionless quantity

$$z = R_{iL}\, N_{V\,max.}/E_a^2$$

is introduced, and the quantities whose evaluation

is sought are expressed in terms of z. The limitation of the d.c. input in class A amplifiers, and of the anode load in class B amplifiers, by the maximum permissible anode loss of the valve yields characteristic values for z ($z_A = 0.25$, $z_B = 0.1$). Above and below these characteristic values various matching conditions hold good: these are given [in tables and in curves]. For large values of z (*e.g.* for small anode potentials) the available outputs from A– and B– amplifiers do not differ. For the characteristic value itself the A–amplifier output is $0.25\ N_{W\,max.}$, that of the B–amplifier $0.6\ N_{W\,max.}$. In the limiting case ($z = 0$) the output of the A–amplifier becomes $0.5\ N_{W\,max.}$, that of the B–amplifier $2.5\ N_{W\,max.}$ The ratio of the two efficiencies in the limiting case is 0.5 : 0.78. With the B–amplifier a complication is caused by the fact that in variable modulation the maximum anode load may occur not at full but at lower modulation. This must be allowed for by a suitable choice of external resistance.

(*c*) A separate investigation of the triode controlled in the region of grid current shows its great superiority over the triode without grid current, especially for small anode voltages. The anode voltage, however, must not be below the value $E_a = \sqrt{R_{iW} N_{W\,max.}}$, so that R_{iL} should be $\leqq 0.25\ R_{iW}$.

(*d*) It seems necessary to point out that the above work, while dealing intimately with the problem of the output stage, does so exclusively from the point of view of the obtainable outputs and of the efficiency, but that such complex and important matters as the problems of linear and non-linear distortion, input to the input amplifier and to the rectifier, are completely neglected. Thus the above results by themselves cannot be used as fundamental grounds for a decision between this or that arrangement, but are intended rather as a contribution to the discussion of the most effective design of an output stage.

AVERAGE ENERGY SPECTRUM OF A BROADCASTING STATION, AND ITS MEASUREMENT.—P. P. Eckersley. (*See* abstract under "Stations, Design and Operation.")

SUPERVISORY AND CONTROL EQUIPMENT FOR AUDIO-FREQUENCY AMPLIFIERS.—Sohon. (*See* under "Stations, Design and Operation.")

DIE ARBEITSWEISE DES GLIMMLAUTSPRECHERS (How the Glow Loud Speaker Works).—A. Gemant. (*Physik. Zeitschr.*, 15th Feb., 1933, Vol. 34, No. 4, pp. 158–164.)

The glow loud speaker is a direct current corona with superposed audio frequency; the acoustic pressure produced by it is proportional to the impressed alternating voltage. The frequency characteristic drops at low frequencies and also at those above 7 000 c/s, the maximum at 3 000 c/s being presumably due to resonance with the oscillating space charge. The best arrangement is a complete cylindrical electrode with the glowing wire arranged along the generators of a concentric cylinder. Properties of the loud speaker are investigated. *Cf.* Fleischmann (AEG), 1929 Abstracts, p. 276.

ELECTRODYNAMIC LOUD SPEAKER OF SPECIAL DESIGN FOR LARGE OUTPUTS.—Telefunken Company: Gerdien and Neumann. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 38.) *See* Fig. 20: also 1931 Abstracts, p. 158, and back reference.

CIRCUIT FOR DISCONNECTING MOVING COIL FROM AMPLIFIER WHEN FIELD EXCITATION FALLS BELOW A LIMITING VALUE (avoiding Strain on Diaphragm, and Accompanying Noises, on switching Field Current.).—(Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, pp. 35–36.)

DIE BEEINFLUSSUNG EINER TELEPHONMEMBRAN DURCH EIN LUFTPOLSTER MIT ABSORBIERENDER ABSCHLUSSWAND (The Influence of an Air Cushion with Absorbing Back Wall on a Telephone Diaphragm).—K. Schuster and A. Hohberg. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 2, pp. 203–216.)

RELATED NODAL LINES ON CHLADNI PLATES.—R. C. Colwell. (*Journ. Acoust. Soc. Am.*, No. 1, Part I, Vol. 4, 1932, p. 3: summary only.)

THE "KLARTON" PROCESS, WITH SPECIAL ATTENTION TO THE ELECTRO-OPTICAL AND PHOTOGRAPHIC CONDITIONS.—H. Lichte and A. Narath. (Summaries in *Physik. Ber.*, 1st and 15th Jan., 1933, Vol. 14, Nos. 1 and 2, pp. 55 and 152.)

THE BREUSING–VON HARTEL SOUND FILM RECORDING PROCESS.—M. P. Rubert. (*Kinotechnik*, No. 21, Vol. 14, 1932, pp. 375–377.)

DER RÖNTGENBILDTONFILM (The X-Ray Sound Film [for the Study of the Heart, Lungs, etc.]).—H. Grosse. (*E.T.Z.*, 23rd Feb., 1933, Vol. 54, No. 8, pp. 177–178.)

The combination of sound recording with X-ray cinematography brings with it a special difficulty in the matter of the exact synchronisation which is so essential if the full value of the film is to be obtained. The writer describes how his patented process overcomes this difficulty. The picture-recording camera and the sound-recording apparatus are started before the X-ray tube is excited. Simultaneously with the switching-on of the latter, an indicating note (of such a pitch that it will not interfere with the reproduced sounds) is sent going. Thus in reproducing the film, exact synchronisation is obtained by adjusting the beginning of the pictures to coincide with the beginning of the indicating note.

RECENT FUNDAMENTAL ADVANCES IN MECHANICAL SOUND RECORDS ON WAX DISCS USING VERTICAL CUT. DEMONSTRATION.—H. A. Frederick. (*Journ. Acoust. Soc. Am.*, No. 1, Part I, Vol. 4, 1932, p. 7: summary only.)

THE EVOLUTION OF THE GRAMOPHONE.—Richard Arbib. (*Wireless World*, 3rd February, 1933, Vol. 32, pp. 80–83.)

[Gramophone] Amplifier Designs.—H. B. Dent. (*Wireless World*, 3rd Feb., 1933, Vol. 32, pp. 92–96.)

A battery-operated amplifier, with quiescent push-pull, and a d.c. mains-operated amplifier using the latest types of indirectly heated d.c. mains valves.

Absolute Nullstellen in einwellig beschallten Räumen (Absolute Null Points of Sound Pressure produced by a Sinusoidal Sound Wave in a Room).—P. C. Hermann. (*Hochf:tech. u. Elek:akus.*, Feb., 1933, Vol. 41, No. 2, pp. 64–65.)

General considerations show that interference between direct and reflected waves is likely to form lines of such null points : experiment confirms this, several spiral null-lines being found, especially in the corners of the room. In open space such null-lines can be formed by the use of three or more sources of sound : if these have directive properties, two sources are enough.

Passage through such a null-line produces a phase rotation of 360°. This was shown experimentally, the microphone being kept stationary and the null-line moved from one side of it (AA, Fig. 2) to the other (BB), by gradually altering the note frequency ; by the use of a Franke machine the change of phase during the operation was watched.

Raumakustische Modellversuche und Messung akustischer Absorptionskoeffizienten (Model Tests on Room Acoustics and the Measurement of Acoustic Absorption Coefficients [with particular reference to the Dependence of the Reverberation Time on the Position of the Absorbing Material]).—U. Khuner. (Summary in *Physik. Ber.*, 15th Jan., 1933, Vol. 14, No. 2, pp. 173–174.)

A New Reverberation Formula.—W. J. Sette. (*Journ. Acoust. Soc. Am.*, No. 1, Part I, Vol. 4, 1932, p. 8 : summary only.)

On the assumption that a sound ray, in repeated reflections, reaches the various surfaces of the room in proportion to their surface areas, an expression for the reverberation time is found involving the logarithm of the geometrical mean of the reflection coefficients.

An Acoustic Constant of Enclosed Spaces Correlatable with Their Apparent Liveness.—W. J. Albersheim and J. P. Maxfield. (*Ibid.*, p. 8.)

On the Acoustical Properties of Parabolic Reflectors.—K. Satô and M. Sasao. (Reference in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 14.)

Automatic Logarithmic Recorder for Frequency Response Measurements.—S. Ballantine. (*Journ. Acoust. Soc. Am.*, No. 1, Part I, Vol. 4, 1932, p. 10 : summary only.)

Acoustic Measuring Instruments.—R. L. Hanson. (*Ibid.*, p. 10.)

Untersuchungen über akustische Schwellenwerte. II. Das Thermophon und seine Verwendung als akustisches Messinstrument (Investigations on Acoustic Threshold Values. II. The Thermophon and its Use as an Acoustic Measuring Instrument).—W. Geffcken and L. Keibs. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 4, pp. 404–430.)

For reference to the first paper in this series *see* 1932 Abstracts, pp. 42 and 99, r.-h. columns.

An Experimental Determination of the Equivalent Loudness of Pure Tones [from 62 to 16 000 c/s].—W. A. Munson. (*Journ. Acoust. Soc. Am.*, No. 1, Part I, Vol. 4, 1932, p. 7 : summary only.)

Special Noise Testing Equipment.—D. H. MacNee. (*Elec. Communication*, Jan., 1933, Vol. 11, No. 3, pp. 128–134.)

Notiz zur empfindlichen Flamme nach Tyndall (Note on Tyndall's Sensitive Flame).—J. Zahradníček. (*Physik. Zeitschr.*, 15th Feb., 1933, Vol. 34, No. 4, p. 182.)

A description of a gas burner used to produce a sensitive flame with normal gas pressure. *Cf.* Zickendraht, March Abstracts, p. 167.

Fourier Analysis and Vowel Curves.—R. H. Nisbet. (*Nature*, 18th March, 1933, Vol. 131, p. 401.)

This letter suggests, in extension of a letter by Scripture (April Abstracts, p. 218), that a vowel curve might be analysed by considering it as that of a " carrier note " with modulation, not necessarily sinusoidal but perhaps more complex.

Researches on the Structure of the Vowels [and the Experimental Confirmation of Paget's Two Characteristic Frequencies due to Posterior and Anterior Resonances].—P. Kucharski. (*Comptes Rendus*, 21st Nov., 1932, Vol. 195, pp. 979–981.)

The Influence of Side Tone upon the Intelligibility of Telephone Communication [and Results of Phrase Intelligibility Tests by means of Lists of Questions].—L. C. Pocock. (*Elec. Communication*, Jan., 1933, Vol. 11, No. 3, pp. 135–139.)

The Effect of Humidity on Supersonic Velocity in Air [Theoretical and Experimental Investigation].—M. Kinoshita and C. Ishii. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 13.)

Experimental Methods for the Production and Study of Supersonic Vibrations. In " A Brief Survey of Supersonics."—J. C. Hubbard. (Summary in *Review Scient. Instr.*, Jan., 1933, Vol. 4, No. 1, p. 40.)

A Brief Survey of Supersonics.—J. C. Hubbard. (*Journ. Acoust. Soc. Am.*, Oct., 1932, Vol. 4, No. 2, pp. 99–107.)

EFFECT OF SUPERSONIC VIBRATIONS ON UNSTABLE SYSTEMS.—R. W. Wood. (*Engineer*, 10th March, 1933, Vol. 155, No. 4026, p. 247.)

Short note. Experiments with frequencies from 100 000 to 700 000 c/s show that "in general, any unstable system rapidly approaches equilibrium under the influence of intense supersonic vibrations. Superheated liquids boil violently on exposure to such vibrations, and explosions may take place with sensitive chemicals. There is evidence that some unstable molecules may be literally shaken to pieces, even though the rate of vibrations is far below the 'natural period' for the molecules concerned."

CHEMICAL AND BIOLOGICAL EFFECTS OF ULTRA-SONIC RADIATION.—A. Szent-Györgyi. (*Nature*, 25th Feb., 1933, Vol. 131, p. 278.)

SOUND ABSORPTION IN MOLECULAR GASES.—H. O. Kneser. (*Phys. Review*, 1st Feb., 1933, Series 2, Vol. 43, No. 3, p. 215: abstract only.)

SCHALLABSORPTION IN MEHRATOMIGEN GASEN (Absorption of Sound in Molecular Gases).—H. O. Kneser. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 3, pp. 337–349.)

German version of the full paper, an abstract of which is referred to above.

ZUR DISPERSIONSTHEORIE DES SCHALLES (The Dispersion Theory of Sound).—A. J. Rutgers. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 3, pp. 350–359.)

REMARK ON THE PRECEDING PAPER BY A. J. RUTGERS.—H. O. Kneser. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 3, pp. 360–361.) *See* above reference.

STUDIES ON THE SOUNDS EMITTED BY REVOLVING AIRSCREWS.—J. Obata, Y. Yosida, and S. Morita. (Summaries in *Physik. Ber.*, 1st and 15th Feb., 1933, Vol. 14, Nos. 3 and 4, pp. 174 and 254–255.) *Cf.* Eisner, Rehm and Schuchmann, January Abstracts, p. 46.

PHOTOTELEGRAPHY AND TELEVISION

NOTES ON THE WESTON PHOTRONIC PHOTOELECTRIC CELL.—B. P. Romain: Bartlett. (*Review Scient. Instr.*, Feb., 1933, Vol. 4, pp. 83–85.)

Following on Bartlett's work referred to in Jan. Abstracts, p. 47 (l–h. col.). "The purpose of this paper is to show that the internal leakage path in the photronic cell may be regarded as consisting of three conductances which are: (1) a conductance which is a constant for a given cell; (2) a conductance which is directly proportional to the illumination of the cell; (3) a conductance which is directly proportional to the total internal leakage current in the cell. Experimental data are presented which apparently justify this conception, and formulas are developed from which the current in the external circuit and the open circuit e.m.f. may be calculated under varying conditions of use."

AN EXTRAORDINARY PHOTOELECTRIC CELL.—(*Journ. Franklin Inst.*, Jan., 1933, Vol. 215, No. 1, p. 68.)

Short note only on a recently developed photoelectric cell containing a highly sensitive light disc which transforms light energy directly into electric energy without the use of any auxiliary voltage and delivers about 120 microamperes per lumen.

"VISITRON" PHOTOELECTRIC CELLS WITH NORMAL SENSITIVITIES FROM 100 TO 150 MICROAMPERES PER LUMEN.—(*Electrician*, 6th Jan., 1933, Vol. 110, No. 2849, p. 13.)

REVERSAL OF CURRENT IN RECTIFIER PHOTO-CELLS.—J. Guild. (*Nature*, 4th March, 1933, Vol. 131, pp. 327–328.)

A letter confirming and extending the observations of Poole and Atkins (April Abstracts, p. 221.)

EXISTENZ EINES INNEREN PHOTOEFFEKTES IM KUPFEROXYDUL (Existence of an Internal Photoelectric Effect in Cuprous Oxide).—D. Nasledow and L. Nemenow. (*Naturwiss.*, 10th March, 1933, Vol. 21, No. 10, p. 205.)

The writers illuminated a plate of cuprous oxide, 0.3 mm thick, covered with gold and with no barrier layer, by means of a 500-watt lamp with water filter and condenser. At room temperature there was neither an internal nor a barrier-layer photoelectric effect. In liquid air the current rose to twice its value when the specimen was illuminated, but inertia was present and the conclusion was reached that the effect observed was no real internal photoelectric effect but was chiefly due to increase in conductivity caused by rise of temperature. This source of error can be completely avoided by keeping the conductivity in the absence of illumination vanishingly small compared to the photoelectric current.

ÜBER DIE ELEKTRIZITÄTSBEWEGUNG DURCH LICHT, WÄRME UND KATHODENSTRAHLEN IN BLEIGLANZ-EINKRISTALLEN (On the Movement of Electricity Caused by Light, Heat and Cathode Rays in Single Crystals of Galena).—E. Rupp. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 7/8, pp. 483–494.)

ÜBER DEN SÄTTIGUNGSSTROM BEI LICHTELEKTRISCHER LEITUNG DES RÖNTGENISIERTEN STEINSALZES (The Saturation Current in the Photoelectric Conductivity of X-Rayed Rock Salt).—N. Kalabuchow. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 7/8, pp. 534–541.)

ÜBER DAS VERHALTEN VON SPERRSCHICHT-PHOTOZELLEN BEI BELICHTUNG MIT RÖNTGENSTRAHLEN (On the Behaviour of Barrier-Layer Photoelectric Cells on Exposure to X-Radiation).—K. Scharf and O. Weinbaum. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 7/8, pp. 465–482.)

Authors' summary:—For the first time quantitative measurements have been undertaken of the photo-electromotive forces arising on illumination of cuprous oxide and selenium barrier-layer photoelectric cells by X-radiation, as functions of the

intensity and frequency of the latter. Selenium barrier-layer cells also show fatigue phenomena; these are investigated.

THE BECQUEREL EFFECT AT SELENIUM ELECTRODES.—M. Volmer and W. Moll. (Summary in *Physik. Ber.*, 15th Jan., 1933, Vol. 14, No. 2, p. 144.)

SUR LA DIFFÉRENCIATION DES EFFETS ÉLECTRONIQUES ET DES EFFETS PHOTO-ÉLECTROCHIMIQUES DANS LES ELEMENTS PHOTOVOLTAIQUES (On the Differentiation between the Electronic and the Photo-electrochemical Effects in Photovoltaic Cells).—R. Audubert. (*Comptes Rendus*, 13th Feb., 1933, Vol. 196, No. 7, pp. 475–478.)

In previous papers (1932 Abstracts, pp. 46—two —and 174) the writer showed that photovoltaic effects are chiefly due to photo-electrochemical phenomena in which the water plays an essential part, but that purely electronic effects may also come in. Taking the case of a cell with copper–copper oxide electrodes, he shows that a study of the photovoltaic characteristics at various frequencies, in selected electrolytes, allows the two effects to be separated, and confirms the existence of a comparatively feeble internal electronic process confined to the copper–copper oxide surface of separation and particularly noticeable with layers of little thickness. With such electrodes, therefore, it is possible to have a superposition of two effects which are inverse and of very different sensitivities over the spectrum: this explains the observations of Athanasiu (March Abstracts, p. 169).

ÜBER DIE CHEMISCHEN UND PHYSIKALISCHEN BEDINGUNGEN DER LICHTELEKTRISCH WIRKSAMEN WASSERSTOFFBELADUNG DES PLATINS UND PALLADIUMS (The Chemical and Physical Conditions of the Photoelectrically Active Hydrogen Load of Platinum and Palladium).—G. Bethe. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 11/12, pp. 701–725.)

SUR LA SENSIBILITÉ SPECTRAL DES CATHODES PHOTOÉLECTRIQUES À L'OXYDE DE CAESIUM (The Spectral Sensitivity of Caesium Oxide Photoelectric Cathodes [and Its Variation with Time]).—G. Déjardin and R. Latarjet. (*Comptes Rendus*, 13th Feb., 1933, Vol. 196, No. 7, pp. 470–473.)

See also Prescott and Kelly, 1932 Abstracts, pp. 592 and 648, with whose results the observations here noted and discussed are in good general agreement.

DER LICHTELEKTRISCHE EFFEKT AN MAGNESIUMOBERFLÄCHEN (The Photoelectric Effect at Magnesium Surfaces).—H. Gerding and R. Gerding-Kroon. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 48.)

Extension of the work referred to in 1931 Abstracts, p. 446 (on aluminium and its alloys) to magnesium.

SPECTRAL SENSITIVITY CURVES OF SODIUM, CADMIUM, AND TITANIUM PHOTOELECTRIC CELLS [in connection with the Measurement of Ultra-Violet Radiation].—A. H. Taylor. (*Journ. Opt. Soc. Am.*, Feb., 1933, Vol. 23, pp. 62–66.)

PHOTOELECTRIC AND METASTABLE ATOM EMISSION OF ELECTRONS FROM SURFACES IN THE RARE GASES.—C. Kenty. (*Phys. Review*, 1st Feb., 1933, Series 2, Vol. 43, No. 3, pp.181–193.)

PHOTOELECTRIC CELL WITH GRID FOR CARRIER FREQUENCY, USED IN COMPENSATION CIRCUIT SO THAT NO A.C. FLOWS IN EXTERNAL CIRCUIT IN ABSENCE OF ILLUMINATION.—Telefunken Company: Schriever. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 37.) *See* Fig. 17.

SUR UN RÉGIME DE FONCTIONNEMENT DE CELLULES PHOTOÉLECTRIQUES À ATMOSPHÈRE GAZEUSE (On a Working Régime of Gas-Filled Photoelectric Cells [the Hemispherical Dunoyer Cell "SCAD Series S"]).—L. Dunoyer and P. Paounoff. (*Comptes Rendus*, 6th March, 1933, Vol. 196, No. 10, pp. 684–686.)

For a description of the particular cell here dealt with *see* 1929 Abstracts, pp. 515–516; *also* Boutry, March Abstracts, p. 169. Doubt having been expressed as to the real existence of the "second régime" in which "perfectly stable and remarkably intense" currents can be obtained, the writers now investigate the phenomenon and its causes. It seems that the shape of the cell and the arrangement of the electrodes and of the insulating surfaces have considerable importance in the production of this régime, which appears due to positive ions producing a direct ionisation of the atoms of the sensitive layer and consequently a secondary electron emission, not photoelectric but recalling the emission which occurs in an electric arc.

SUR L'ACTION D'UN FAISCEAU DE LUMIÈRE PÉRIODIQUE SUR DES LAMES MÉTALLIQUES (The Action of a Beam of Periodic Light on Some Metallic Films).—Q. Majorana. (*Comptes Rendus*, 6th Feb., 1933, Vol. 196, No. 6, p. 396.)

Continuation of the researches dealt with in March Abstracts, p. 170. The new results seem likely to lead to some modification of the conclusions drawn from the previous experiments.

THE NEW GAS DISCHARGE TUBES, AND THEIR APPLICATION TO TELEVISION.—N. L. Harris. (*Television*, March, 1933, Vol. 6, No. 61, p. 119: summary only.)

FELDSTÄRKE UND IONENKONZENTRATION VOR DER KATHODE EINER BOGENENTLADUNG (Field Strength and Ion Concentration near the Cathode of an Arc Discharge).—W. de Groot. (*E.T.Z.*, 2nd Feb., 1933, Vol. 54, No. 5, pp. 111–112.)

Summary of the Dutch paper referred to in 1932 Abstracts, p. 103.

THE BAIRD GRID [Kerr] CELL.—Baird Company. (*Television*, Feb., 1933, Vol. 6, No. 60, p. 67.)

"The new Baird grid cell, consisting principally of a set of thin interleaved electrodes . . . in nitro-benzene" has "minute inertia," gives light variations practically proportional, "over a definite

range," to the voltage variations, and works at voltages available in an ordinary wireless set, especially if this is mains-driven.

TWO-WAY TELEVISION AS A PUBLIC UTILITY SERVICE.—J. C. Wilson. (*Television*, Feb., 1933, Vol. 6, No. 60, p. 63.)

Continuation of a correspondence. "A special technique is being developed elsewhere to deal with the complicated mathematical treatment of line correction problems . . . and I am sure that the Post Office engineers are better fitted to take charge of this section of the development than are the engineers of private concerns who must be trained practically *ab initio*. The application of known systems for the reduction of frequency band (such as the artificial Döppler effect, and skewing the spectrum in the frequency/time plane) to duplex television, I maintain, belongs properly to a line-engineering department which, in this country, is State-controlled. . . ."

FIVE YEARS: THE DEVELOPMENT OF THE [Baird Television] PROGRAMMES. (*Television*, March, 1933, Vol. 6, No. 61, pp. 96–99.)

SIGHT AND SOUND ON ONE WAVE [Sound Impulses converted into Light Impulses which are used as Part of the Scene to be Televised].—F. Wood. (Outline of Patent in *Television*, Feb., 1933, Vol. 6, No. 60, p. 62.)

"SELF-CENTRED" TELEVISION [a Criticism].—A. E. Boardman: De Wet. (*Television*, Feb., 1933, Vol. 6, No. 60, p. 65.) *See* February Abstracts, p. 108.

A NEW MULTIPLE CATHODE-RAY OSCILLOGRAPH.—Boekels and Dicks. (*See* under "Subsidiary Apparatus and Materials.")

NEW RESEARCH ON CATHODE RAYS.—Baird Company. (*Television*, Feb., 1933, Vol. 6, No. 60, pp. 47–48.)

MARCONI TELEVISION AMPLIFIER WITH FLAT RESPONSE CHARACTERISTICS FROM 10 CYCLES TO 150 KILOCYCLES.—Marconi Company. (*Marconi Review*, Jan.–Feb., 1933, No. 40, pp. 27–28.)

Outline of the amplifier shown at the Physical Society's Exhibition (*see* under "Miscellaneous"). "In order to obtain the widest possible frequency spectrum, new methods have been used for amplification and for response correction. Throughout the equipment no transformers or other iron-core components have been utilised, and a method of resistance amplification, using screen-grid valves, has been developed to avoid the losses associated with ordinary triode circuits. Special methods of compensation have allowed the flat frequency-response region at both low- and high-frequency ends to be very much extended, and care has been exercised in keeping to a minimum both phase shift and harmonic production. . . . Provision is made in the photo-electric pick-up unit for a limited correction for droop in photoelectric cell response, and units are provided to meet the requirements of different types of cells, etc. The overall magnification of the first amplifying unit is of the order of 100 db. The voltage amplification of the second amplifier is relatively low, as it is designed more as a power converter. . . ."

A MORE COMPACT MIRROR DRUM? [Several Small-Diameter Adjacent Drums on Same Axis, Mirrors suitably Tilted and Staggered].—A. Everett. (*Television*, Feb., 1933, Vol. 6, No. 60, p. 74.)

REFLECTING VALUES OF LIGHT [Experimental Values of Proportions of White Light reflected from Variously Coloured Materials].—F. Wood. (*Television*, Feb., 1933, Vol. 6, No. 60, pp. 64–65.)

FADING ELIMINATION, ESPECIALLY IN PHOTO-TELEGRAPHY.—Int. Gen. Elec. Company. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 224.)

Signals and spaces are on different wavelengths, and the recording lamp is maintained (in the absence of all signals) at a moderate brightness, which is increased by the one wave and extinguished by the other. Sufficient contrast is thus ensured even if a spacing or a marking signal fails.

MEASUREMENTS AND STANDARDS

NEW METHOD OF MEASURING ELECTRIC AND MAGNETIC PROPERTIES OF METALS IN THE REGION OF ULTRA-SHORT ELECTROMAGNETIC WAVES.—G. Potapenko and R. Sanger. (*Phys. Review*, 1st Feb., 1933, Series 2, Vol. 43, No. 3, pp. 210–211.)

Abstract only. The metals are used as wire-bridges in a Lecher wire system, for which a theory is developed. Undamped waves in the region of wavelengths from 10 to 100 cm are used in the experiments.

METHOD OF FIELD-STRENGTH MEASUREMENT, ESPECIALLY FOR ULTRA-HIGH FREQUENCIES.—K. Sohnemann. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 224.)

The oscillations of an audion with strong reaction coupling are periodically quenched by a supersonic quenching frequency; the consequent "mush" is weaker, the greater the amplitude of the incoming r.f. signal, and is taken as a measure of the field strength.

AN APPARATUS FOR MEASURING THE [Radio-] FREQUENCY SPECTRUM OF SOURCES OF INTERFERENCE WITH BROADCAST RECEPTION.—Wild: Siemens & Halske. (*See* under "Reception.")

VERFAHREN ZUR MESSUNG VON OBERWELLEN IN HOCHFREQUENZKREISEN MITTELS EINES WELLENMESSERS (Method of Measuring Harmonics in H.F. Circuits by means of a Wavemeter).—M. Osnos. (*Telefunken-Zeit.*, Dec., 1932, Vol. 13, Vol. 62, pp. 44–47.) *See* January Abstracts, p. 48.

QUARTZ CRYSTAL AND THERMOSTAT IN BULB.—Telefunken Company: Bechmann. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 36.) *See* Fig. 12.

VARIATION OF DIELECTRIC CONSTANT OF QUARTZ WITH APPLIED POTENTIAL [and with Temperature].—H. Saegusa and K. Nakamura. (*Science Rep. Tôhoku Imp. Univ.*, No. 3, Vol. 21, 1932, pp. 411–438.)

If the plate is cut parallel to the optical axis, no variation of dielectric constant with applied potential is found, up to 12 kv/cm; but if it is cut perpendicular to the axis, its constant increases exponentially with the potential from 2 kv/cm upwards. A preliminary experiment on the variation with temperature is described.

THE USE OF TRIODE AND TETRODE VALVES FOR THE MEASUREMENT OF SMALL D.C. POTENTIAL DIFFERENCES.—T. P. Hoar. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, pp. 19–25.)

"Recently a large and widely diffused literature dealing with valve potentiometers and electrometers has appeared. It is the purpose of this article to summarise the various modifications which have been proposed, to indicate some of the practical difficulties which arise, and to suggest suitable circuits for use in particular problems."

AN IMPROVEMENT IN VACUUM TUBE VOLTMETERS [for Audio-frequencies: Single Voltage Source, Direct Reading, Absence of Zero Adjustment, etc.].—R. M. Somers. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 56–62.)

Depending for its operation almost entirely on the amplification factor of the valve. The load impedance of the indicating instrument is made effectively to equal several times the valve plate impedance by the introduction of a transformer (Fig. 1A) or, for less sensitivity but a better frequency characteristic, of an output network as in Fig. 1B.

CORRECTION OF FREQUENCY ERROR IN MOVING-IRON VOLTMETERS.—A. Campbell: R. O. Carter: D. C. Gall. (*Journ. Scient. Instr.*, Jan., 1933, Vol. 10, pp. 24–25.)

Further correspondence on Carter's paper (March Abstracts, p. 172).

DAMPING AND RESONANCE WITH AN EINTHOVEN STRING GALVANOMETER.—A. H. Bebb. (*Journ. Scient. Instr.*, March, 1933, Vol. 10, pp. 75–83.)

Author's abstract:—This paper gives the theory of conditions necessary to maintain the Einthoven string galvanometer in the critical condition with and without inductance in circuit. Records are given showing agreement with theory, and a comparison between these circuits when the field strength only is varied. Also, when a sinusoidal electromotive force is applied, the conditions under which the string resonates are considered, and graphs plotted showing amplitudes against impressed frequencies; these also show fair agreement with theory. In a non-inductive circuit resonance is not possible when the string is in the critical condition, but the presence of inductance modifies the conditions considerably.

A VIBRATION GALVANOMETER WITH DEFLECTION RANGE INDEPENDENT OF FREQUENCY.—W. Meissner and U. Adelsberger. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 14, 1933, pp. 111–118.)

Completion of the paper dealt with in January Abstracts, p. 50. From the energy equations a simple formula is derived for the calculation of a matching transformer between galvanometer and "generator," *e.g.* an amplifier valve.

CHARACTERISTICS OF THERMO-AMMETERS [Hot-Wire and Thermo-Couple Type] FOR USE AT RADIO FREQUENCIES.—M. Takaya. (*Res. Electrotech. Lab., Tokyo*, No. 329, 1932, 51 pp.)

The paper is in Japanese, but there is an English summary and a very long bibliography. The frequency characteristics of eighteen ammeters, whose ranges varied from 10 to 1 000 mA, were investigated by means of differential air calorimeters. It was found that "they are independent of frequency within the limit of 0.5% at least up to 6 000 kc/s, with the exception of Moll's thermo-converter with a correction factor of −1.4% and of the thermo-shunt type with −1% at 6 000 kc/s. When the ammeters have different potential with respect to other neighbouring bodies, the indication is affected by stray capacities, whereas the hot-wire and the non-contact type thermo-junctions are little affected, at least at 6 000 kc/s, the contact type thermo-junctions being affected at 4 000 kc/s and upwards. This effect can be eliminated by shielding and connecting the shield to one of the terminals of the instrument." Among other results, it was found that the apparent thermo-e.m.f. of the self-heating type of thermo-junction heated by d.c. does not coincide with the e.m.f. when heated by a.c.; this type should be calibrated with a.c. The apparent difference in the thermo-e.m.fs of the contact and self-heating types, produced by a change of polarity of the heating current, is also investigated.

THE TEMPERATURE COEFFICIENT OF THE SATURATED WESTON CELL.—P. Vigoureux and S. Watts. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 172–179.)

ELECTRICAL AND MAGNETIC UNITS.—E. Griffiths. (*Nature*, 31st Dec., 1932, Vol. 130, pp. 987–989.)

A short account of the discussion at an informal conference on electrical and magnetic units held at the recent Electrical Congress in Paris.

THREE SUPERFLUOUS SYSTEMS OF ELECTROMAGNETIC UNITS.—G. A. Campbell. (*Physics*, Nov., 1932, Vol. 3, No. 5, pp. 230–239.)

CONFERENCE OF THE SYMBOLS, UNITS AND NOMENCLATURE COMMISSION OF THE INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS, AT PARIS, JULY, 1932, AND ITS RESULTS.—A. E. Kennelly. (*Proc. Nat. Acad. Sci.*, Jan., 1933, Vol. 19, pp. 144–149.)

THE OERSTED.—Notes from the U.S. Bureau of Standards. (*Journ. Franklin Inst.*, Jan., 1933, Vol. 215, No. 1, p. 100.)

A note on the adoption and use of the name "oersted" for the unit of magnetising force (magnetic intensity).

SUBSIDIARY APPARATUS AND MATERIALS

DIE ABSCHIRMUNG DES MAGNETISCHEN FELDES VON ZYLINDERSPULEN (The Screening of the Magnetic Field of Cylindrical Coils).—N. Hillers. (*Telefunken-Zeit.*, Dec., 1932, Vol. 13, No. 62, pp. 13–28.)

A theoretical and experimental investigation leading to the following general conclusions:—the screening of the magnetic field of cylindrical coils is accomplished with closed cylinders of materials which are good electrical conductors. The arrangement behaves as an air-cored transformer whose load is the resistance of the screen. Two effects must be distinguished: the "internal" and the "external" reactions, which are indissolubly linked. The former is the effect, on the coil itself, of the induced currents flowing in the screen and of the energy consumed in the latter; the regular relation between internal reaction and the external load is shown by the transformer diagram (Barkhausen). The external reaction is the screening effect, *i.e.*, the reduction of the field outside the screen by the geometrical addition of the fields due to the currents in the coil and in the screen.

Since the internal and external reactions are so strongly linked together, information concerning the latter also can be obtained from the transformer diagram. In this way simple formulae are derived showing the dependence of the screening action on the thickness of the screen wall, on its material, and on the frequency. These formulae are confirmed by experiments with copper and zinc screens. The following results are obtained:—(*a*) the screening action remains constant if the product of wall thickness, conductivity and frequency is constant; (*b*) it is completely specified by giving the effective resistance and the effective inductance of the screen; (*c*) the screen should be at least as long as the coil; (*d*) the maximum screening effect, fundamentally, is given when the screen closely surrounds the coil, so that the two fields correspond completely. But in practice a too closely fitting screen is unsatisfactory on account of the internal reaction on the coil, and the design in this respect must be a compromise between the desirable amount of screening and the permissible reaction on the coil. As a general rule the cross section of the coil should be between 0.5 and 0.3 times the cross section of the screening cylinder.

(*e*) The screening effect when the coil is considered as a magnetic dipole, and the measuring (pick-up) coil is made very small, is found to be equal to the screening as found above, provided the screen is long compared with the coil; (*f*) multiple screening is effective, but its effectiveness depends on the coupling between the two screens being very loose; the best result, therefore, is obtained by putting the second screen over the "receiving" coil (the coil which requires protecting from the influence of the "transmitting" coil) instead of over the latter; (*g*) for radio frequencies such as 150 kc/s, and thick screens, a limit is reached for the screening action, owing to the increased influence of skin effect on the resistance of the screen. This limit, however, is very high. *See* also King, April Abstracts, p. 206.

SKIN EFFECT IN A STRATIFIED CYLINDER OF CIRCULAR SECTION [such as a Wire with a Coating of Another Metal].—Strutt. (*See* under "Properties of Circuits.")

HOW FERROCART IS MADE.—Alfred Schneider. (*Wireless World*, 17th March, 1933, Vol. 32, p. 203.)

A technical description of the manufacture of the special iron core used in the tuning coils referred to in January Abstracts, p. 39, r.-h. column.

ISOPERME, A MAGNETIC MATERIAL FOR TELEPHONE ENGINEERING.—R. Goldschmidt and J. Pfaffenberger. (Paragraph in *Zeitschr. V.D.I.*, 18th Feb., 1933, Vol. 77, No. 7, p. 182.)

FORMEN DES KLEINSTMOTORS (Types of Very Small Motors [500 Watts downwards]).—F. Bunzl-Geemen. (*E.T.Z.*, 2nd March, 1933, Vol. 54, No. 9, pp. 194–196.)

Including a one-watt motor, driven off a flash-lamp battery, and designed for enclosure in the handle of a safety razor (*ibid.*, p. 219).

A STUDY OF THE THYRATRON COMMUTATOR MOTOR.—C. H. Willis. (*Gen. Elec. Review*, Feb., 1933, Vol. 36, pp. 76–80.)

THE CONSTANT PARAMAGNETISM OF METALLIC RHENIUM.—N. Perakis and L. Capatos. (*Comptes Rendus*, 27th Feb., 1933, Vol. 196, No. 9, pp. 611–612.)

RHENIUM, ITS PROPERTIES AND APPLICATION.—(*E.T.Z.*, 12th Jan., 1933, Vol. 54, No. 2, p. 43.)

SPECIAL IRON FOR VACUUM-TUBE ELECTRODES ["Svea Metal"].—(*Electronics*, Dec., 1932, p. 379.) *See* also Todd, February Abstracts, p. 102.

PLATELESS BATTERIES.—Block Batteries Ltd.: L. Fuller. (*Electrician*, 10th March, 1933, Vol. 110, No. 2858, p. 338; *Engineering*, 10th March, 1933, Vol. 135, No. 3504, p. 288.)

It is claimed, among other things, that this accumulator has about double the ampere-hour capacity of a plate accumulator of the same size, and that it will not run down or sulphate when not in use. "The positive electrode is in the form of a round block, and the negative electrode consists of the lead cylinder and the lead paste with which it is lined." The space between contains the acid and perforated ebonite and glass-wool separators. The container is a bakelite cylinder. A high-tension 5 000 mA accumulator on the same lines is being developed. It will be the same size, within an inch, as a dry battery for radio receivers, and

will be much cheaper than the present h.t. accumulators.

SUR LES ACCUMULATEURS AUX HALOGÈNES (Halogen Salts Accumulators).—J. Reyval: Jumau. (*Rev. Gén. de l'Élec.*, 28th Jan. 1933, Vol. 33, No. 4, pp. 111–115.)

Based on a recently read paper in which Jumau discusses the characteristics of accumulators with electrolytes of chloride, bromide or iodide of zinc (*cf.* 1932 Abstracts, p. 538—Boissier, and below) and concludes that, contrary to various articles, they are still in the laboratory stage.

LES ACCUMULATEURS ÉLECTRIQUES À L'IODE (Iodine Accumulators).—L. Fourcault: Boissier. (*Génie Civil*, 31st Dec., 1932, Vol. 101, No. 27, pp. 660–661.) *See* also 1932 Abstracts, p. 538, and above.

THE CONTROL OF IGNITION-COIL DISCHARGE CHARACTERISTICS.—G. I. Finch and R. W. Sutton. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 288–306.)

THYRATRON-CONTROLLED VOLTAGE RECTIFIERS [for Laboratory Use: employing Selsyn Transformer].—H. W. Hartman. (*Electronics*, Feb., 1933, p. 43.)

SELEN- ODER SELENIDGLEICHRICHTER? (Selenium or Selenide Rectifier?).—W. S. Gripenberg. (*Physik. Zeitschr.*, No. 20, Vol. 33, 1932, p. 778.)

Maintaining that the rectifying layer of a selenium rectifier (iron-selenium-lead alloy) consists of iron selenide.

DIE DIELEKTRISCHEN VERLUSTE VON GLÄSERN IN ABHÄNGIGKEIT VON DER GLASZUSAMMENSETZUNG (The Dielectric Losses of Glass and Their Dependence on Its Composition).—F. Keller. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 14, 1933, pp. 128–131.)

Among results obtained, it was found by tests on a number of glasses that between about 0.25 and 5 megacycles/second the losses increase linearly with the frequency (*see* Fig. 4, for a magnesium-oxide glass).

STROMLEITUNG IN EINEN DIELEKTRIKUM MIT GERINGER LEITFÄHIGKEIT UND MIT EINER BEWEGLICHEN DÜNNEN GELADENEN SCHICHT (Current Conduction in a Dielectric with Small Conductivity and with a Thin Mobile Charged Layer (*e.g.*, Ions at the Electrode)] —W. O. Schumann. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 23–26.)

CONDUCTION OF CURRENT IN A DIELECTRIC WITH ONLY ONE MOBILE VARIETY OF IONS [Mathematical Investigation].—W. O. Schumann. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 7/8, pp. 532–549.)

CURRENT CONDUCTION IN A DIELECTRIC, IN WHICH THE CURRENT-CARRYING IONS ORIGINATE IN AN ELECTRODE [Theoretical Investigation]. —W. O. Schumann. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 7, pp. 843–860.)

THE ELIMINATION OF BACKGROUND "NOISE" IN SENSITIVE PULSE AMPLIFIERS.—L. F. Curtiss. (*Bur. of Stds. Journ. of Res.*, Feb., 1933, Vol. 10, No. 2, pp. 151–154.)

In a previous paper (1932 Abstracts, p. 654) the writer described a 5-stage amplifier for registering the ionisation of individual ionising particles. He now finds that even after due care has been taken to reduce disturbances in the first stages, a great improvement can be effected by modifying the output stage. "It is essential that the output stage should receive a positive impulse from the preceding stage when a pulse comes through. It is also desirable to use two or more pentodes in parallel in the output stage, as shown in Fig. 1. It is then possible to select a bias of such value that the tubes are normally at a point on their characteristic where the curve is practically horizontal but such that a slight shift of the grid potential in the positive direction will cause an increase in the plate current."

STROBOSKOPISCHE UNTERSUCHUNGEN MIT DER BRAUNSCHEN RÖHRE (Stroboscopic Investigations with the Cathode-Ray Oscillograph). —H. E. Hollmann and W. Saraga. (*Hochf: tech. u. Elek:akus.*, Feb., 1933, Vol. 41, pp. 53–56.)

The sense of rotation of the Lissajous figures on a c.-r. oscillograph screen cannot be observed by eye even when the frequency is as low as 5 c/s, so that no information can be obtained as to the direction of the phase displacement between the deflecting voltages, although this is, in many cases, as important as the knowledge of their magnitudes. A stroboscopic method, however, can so reduce the apparent recording speed of the cathode ray that the movements of the latter can be followed by the eye even at very high deflecting frequencies.

This result is attained without the use of any rotating perforated disc or other mechanical device, by modulating the ray intensity at a frequency whose relation to the frequency under investigation is represented by the ratio of two whole numbers. The modulation may be applied to the potential either of the Wehnelt cylinder or of the anode. The resulting bright or dark spots on the Lissajous figure appear stationary if the ratio of the two frequencies is exactly that of two whole numbers, while any deviation from the exact ratio makes them move in one direction or the other over the figure. If the modulation frequency is made *less than* the deflecting frequency or its whole-number ratio (*i.e.*, if the modulating frequency is adjusted to give a stationary effect and then is slightly *decreased*) the apparent rotation of the stroboscopic "time-marks" agrees with the actual ray rotation as regards sense.

If the modulation is applied to the Wehnelt cylinder, a heterodyne generator may be used, its voltage being so regulated that the concurrent sensitivity modulation is not too much in evidence (Figs. 1 and 2). Or a glow-discharge circuit (relaxation oscillation generator) may be used, as in Fig. 3, where the time-marks take the form of short breaks in the figure. Anode-potential modulation naturally requires higher voltages, and sensitivity modulation here plays a greater part than intensity modulation (Fig. 4). A simplified

circuit for Wehnelt cylinder control by relaxation oscillations is shown in Fig. 5, but this has certain disadvantages such as difficulty in maintaining a constant frequency and in adjusting the ray concentration to the most favourable value.

As examples of the working of the method, the writer deals briefly with the investigation of a complex resistance, the phase reversal in a cascade amplifier and in the rectification of a modulated r.f. wave, and the phase displacement in the propagation of an a.f. wave between a loud speaker and a microphone. Researches by Fehr and Kreielsheimer, shortly to be published, on coupled circuit effects are also mentioned.

EINE EINFACHE SCHALTUNG MIT ZWANGLÄUFIGER KOPPLUNG VON STRAHLSPERRUNG UND ZEITABLENKUNG BEIM KATHODENOSZILLOGRAPHEN (A Simple Circuit with Compulsory Coupling of the Beam-Locking Device and the Time Deviation in the Cathode-Ray Oscillograph).—W. Fucks and H. Kroemer. (*Archiv f. Elektrot.*, 14th Feb., 1933, Vol. 27, No. 2, pp. 125–128.)

The circuit referred to is built up on the "trip" relay circuit of Fucks (1932 Abstracts, p. 106). A choke coil is used in conjunction with it to give the linear time base. Only one source of voltage is required. An experimental test of the circuit is described.

TIME-MARKING A CATHODE-RAY OSCILLOGRAM [by Unfocusing the Spot by applying a Periodically Varying Potential to the Wehnelt Cylinder]. — L. F. Richardson. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 135–141.)

EIN KALTKATHODENOSZILLOGRAPH FÜR NIEDRIGE ERREGERSPANNUNG (A Cold-Cathode Oscillograph for Low Excitation Voltage).—W. Rogowski and F. Malsch. (*Archiv f. Elektrot.*, 14th Feb., 1933, Vol. 27, No. 2, pp. 131–133.)

Authors' summary :—With sufficiently high pressure and small dimensions of the discharge tube, cold-cathode oscillographs can be worked with voltages down to about 500 volts.

EIN NEUER MEHRFACHKATHODENSTRAHLOSZILLOGRAPH (A New Multiple Cathode-Ray Oscillograph).—H. Boekels and H. Dicks. (*Archiv f. Elektrot.*, 14th Feb., 1933, Vol. 27, No. 2, pp. 134–136.)

In this new multiple oscillograph, several electron beams are produced in one tube; they may be focused by the same system of concentrating coils. *Cf.* Schlesinger, March Abstracts, p. 168.

CATHODE RAY OSCILLOGRAPHY.—L. H. Bedford. (*Electrician*, 10th March, 1933, Vol. 110, No. 2858, p. 335.)

Summary of a paper read before the Radio Society of Great Britain. "The general mathematical equation for the shape of the ray, taking account of ionisation effects, was explained and the electromagnetic striction effect was discussed. This latter was shown to be unimportant to low voltage tubes, but its theoretical interest from the point of view of the theory of relativity was dealt with at length. The solution for the case of a hard tube was claimed, and a new property of the high-vacuum cathode ray was explained, namely, that any ray of given current and voltage was a tangent to a characteristic cone."

SUR LES TRAJECTOIRES DES ÉLECTRONS DANS UN CHAMP MAGNÉTIQUE LONGITUDINAL (The Trajectories of Electrons in a Longitudinal Magnetic Field). — B. Kwal. (*Comptes Rendus*, 13th March, 1933, Vol. 196, No. 11, pp. 758–760.)

Thibaud found, in addition to rays of periodic concentration and dilatation, thread-like rays of constant diameter (1929 Abstracts, p. 645). The writer's theory, here developed, gives expressions for the extremes between which the cross section of a cathode ray, passing through a longitudinal and uniform magnetic field, may periodically vary, and shows that the filiform rays are only a special case of the rays of periodically varying diameter.

ZUR THEORIE DES ELEKTRONENMIKROSKOPS (On the Theory of the Electron Microscope).—L. Posener. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 11/12, pp. 813–818.)

Author's summary :—It is shown that the magnetic electron microscope gives stigmatic images of prints not lying on the axis. The questions of the magnification and the existence of an index of refraction are also discussed.

ÜBER GEOMETRISCH-OPTISCHE ABBILDUNG DURCH ELEKTRONENSTRAHLEN (On the Formation of Images by Electron Beams on the Lines of Geometrical Optics [Theoretical Investigation]).—W. Glaser. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 7/8, pp. 451–464.)

Author's summary :—The motion of electrons in a given electromagnetic field is regarded as an optical ray system in an inhomogeneous anisotropic medium and the index of refraction corresponding to this medium is given. The methods of the geometrical optics of anisotropic bodies are applied to the case, and the law of refraction thus found for electron beams in the electromagnetic field is used to derive the equation for formation of images in a magnetic field with axial symmetry. Abbé's general sine theorem is extended to the present case of electron beams.

THE GEOMETRICAL-OPTICAL PORTRAYAL OF HOT CATHODES BY ELECTRON RAYS WITH THE HELP OF MAGNETIC FIELDS [Electron Microscope].—M. Knoll, F. G. Houtermans and W. Schulze. (Summary in *Physik. Ber.*, 1st Feb., 1933, Vol. 14, No. 3, p. 212.)

Cf. Abstracts, January, p. 51 (Knoll and Ruska) and February, p. 111 (Brüche and Johannson—two).

ELEKTRONENSTRAHL UND GASENTLADUNG (Electron Beam and Gas Discharge).—E. Brüche. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 4, pp. 377–403.)

This paper combines a number of experimental observations with known phenomena of a gas discharge to give a picture of the connection between the electron beam and the gas discharge. Experiments on the connection between the plasma and

the charge on the walls of the containing vessel, and on the balance of energy and the thickness of the charged layer on the walls, are also discussed.

OPERATION OF THICK-WALLED X-RAY TUBES ON RECTIFIED POTENTIALS [Blocking Action of High Negative Charge on Cold Glass Walls].—L. S. Taylor and C. F. Stoneburner. (*Bur. of Stds. Journ. of Res.*, Feb., 1933, Vol. 10, No. 2, pp. 233–247.)

PHOTOGRAPHY OF FAINT TRANSIENT LIGHT-SPOTS.—L. F. Richardson. (*Nature*, 18th March, 1933, Vol. 131, pp. 401–402.)

The writer has used a Mangin lens-mirror out of a motor-car headlight to photograph a cathode-ray oscillogram. It agrees very nearly with H. Hartridge's specification (March Abstracts, p. 172) of " a lens having a numerical aperture of 0.8 or 0.7, a focal length of 25–50 mm, and adequate definition on the film over an area of 3–5 mm."

AN ARRANGEMENT FOR INTRODUCING PHOTOGRAPHIC PLATES INTO A HIGH VACUUM AND FOR REMOVING THEM THEREFROM.—E. G. Andresen. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, pp. 5–6.)

THE PHOTOGRAPHIC EMULSION: THE MECHANISM OF HYPERSENSITIZATION.—B. H. Carroll and D. Hubbard. (*Bur. of Stds. Journ. of Res.*, Feb., 1933, Vol. 10, No. 2, pp. 211–228.)

QUANTITATIVE STUDY OF THE INHIBITING ACTION OF CERTAIN IONS ON THE FLUORESCENT POWER OF URANINE [the Sodium Salt of Fluorescein].—J. Bouchard. (*Comptes Rendus*, 13th Feb., 1933, Vol. 196, No. 7, pp. 485–487.)

SPECIAL APPARATUS FOR CONTINUED OPERATION OF HIGH-VACUUM PUMPS WITHOUT SUPERINTENDENCE.—W. Pupp. (Summary in *Review Scient. Instr.*, Feb., 1933, Vol. 4, p. 90.)

DIE ZÜNDSPANNUNG VON LEUCHTRÖHREN—STICKSTOFF—BEI VERÄNDERLICHEM ELEKTRODENABSTAND. I. GERADES ROHR (The Breakdown Voltage of Luminous—Nitrogen—Tubes with Variable Electrode Distance. I. Straight Tube).—H. Fricke. (*Physik. Zeitschr.*, 15th Feb., 1933, Vol. 34, No. 4, pp. 168–172.)

For a relay whose action depends on an increase of electrode distance allowing the glow discharge to pass, *see* April Abstracts, p. 227—Landis and Gyr.

DER EINFLUSS DER STEILHEIT DES SPANNUNGSANSTIEGS BEI WECHSELSTROM AUF DIE ZÜNDSPANNUNGEN VON EDELGASEN UND LUFT IN LEUCHTRÖHREN (The Influence of the Steepness of Rise of A.C. Voltage on the Breakdown Potentials of the Rare Gases and Air in Luminous Tubes).—W. Spielhagen. (*Physik. Zeitschr.*, 15th Feb., 1933, Vol. 34, No. 4, pp. 164–168.)

GASEOUS DISCHARGE TUBES FOR RADIO RECEIVER USE [as Visual Tuning Indicator with or without " Noise Gate "].—Dreyer: Senauke. (*See* under " Reception.")

ÜBER DIE STEUERUNG UND AUSLÖSCHUNG EINER GLIMMENTLADUNG IN EINEM ROHR MIT NETZKATHODE UND DRITTER ELEKTRODE (The Control and Extinction of a Glow Discharge in a Tube with Mains-supplied Cathode and a Third Electrode).—E. Badareu. (Summary in *Physik. Ber.*, 15th Jan., 1933, Vol. 14, No. 2, p. 140.)

SODIUM-FILLED TUBES AS ELECTRICAL CONDUCTORS FOR LARGE CURRENTS.—H. H. Dow. (Summary in *Zeitschr. V.D.I.*, 21st Jan., 1933, Vol. 77, No. 3, p. 78.)

VERSUCHE AN DRAHTSEILEN (Tests on Stranded Wires).—F. List. (*Zeitschr. V.D.I.*, 31st Dec., 1932, Vol. 76, No. 53, pp. 1297–1298.)

CONSTANT HIGH OHMIC WIRE RESISTANCES FOR HEAVY LOADING.—A. Jungesblut. (Summary in *Physik. Ber.*, 15th Feb., 1933, Vol. 14, No. 4, pp. 277–278.)

The wire is wound spirally on insulating material in filamentary form. The " resistance cord " thus obtained is woven into ribbon in such a way as to give a bifilar effect and small self capacity. Such resistances will stand 1.2 w/cm², can be made to values up to 10^8 ohm, and can be worked at 1 000 kv. *Cf.* 1932 Abstracts, p. 110 (" Silko ").

MONETTE-HOCHOHMKORDEL (" Monette " High-Resistance Cord [of Resistance Wire wound on Flexible Core]). (*E.T.Z.*, 2nd March, 1933, Vol. 54, No. 9, p. 220.)

The special machinery allows resistance wires down to 0.015 mm in diameter to be closely wound on the core, which is presumably derived from asbestos and may measure 2.5 mm in diameter. In this way a cord can be made having a resistance of 2 megohms per metre length.

DIE ELEKTRISCHE LEITFÄHIGKEIT VON URANDIOXYD UND SEINE ANWENDUNG ALS VORSCHALTWIDERSTAND INSBESONDERE FÜR EISENWASSERSTOFFWIDERSTÄNDE (The Electrical Conductivity of Uranium Dioxide and Its Use as Series Resistance, especially for Iron-in-Hydrogen [Barretter] Resistances).—W. Meyer. (*Zeitschr. f. tech. Phys.*, No. 3, Vol. 14, 1933, pp. 126–128.)

The writer's researches on the electronic conductivity of inorganic compounds led to the discovery that the temperature/conductivity curve of brown uranium dioxide makes this substance particularly suitable for use as a series resistance for iron barretters. Fig. 1 shows how the sudden current rush on switching-on is completely prevented by such a series resistance, while Fig. 4 shows that the merit of the current/voltage curve of the barretter is not affected.

PREVENTION OF FREQUENCY VARIATION DUE TO THERMAL EXPANSION AND CONTRACTION OF INDUCTANCE COILS WITH VARYING LOADS, BY MEANS OF A COMPENSATING CURRENT.—Telefunken Company: H. O. Roosenstein. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Feb., 1933, Vol. 41, No. 2, p. 70.)

RELAYS FOR ELECTRONIC DEVICES [Supersensitive : Telephone Type : Special Purpose Relays : Auxiliary Relays : with Data and Approximate Prices]. (*Electronics*, Feb., 1933, pp. 36–38.)

"SUPER-RESPONSIVE GRAPHERS" WITH OR WITHOUT AUTOMATIC CHANGE OF CHART SPEED.—Everett, Edgcumbe and Company. (*Engineering*, 20th Jan., 1933, Vol. 135, No. 3497, p. 77.)

In an article on the Physical Society's Exhibition. "As compared with the normal form of recording instrument, the torque has been increased about four times and the moment of inertia of the moving parts has been halved, with the result that the pen will move from zero to its maximum reading in less than 1/10 sec." The instrument may be used for recording the modulating current in wireless transmitters. With the automatic speed-change device the chart normally runs at 1″ per hour, while on the occurrence, for instance, of a "fault" on the system under investigation the speed increases automatically to ½″ per second.

EIN EINFACHES VERFAHREN ZUR AUSWERTUNG VON REGISTRIERSTREIFEN (A Simple Method of Analysing Strip Records of Registering Apparatus).—J. Dalchau. (*E.T.Z.*, 16th March, 1933, Vol. 54, No. 11, pp. 253–254.)

Showing how to derive curves for average value, deviation, and fluctuation frequency.

NOTE ON A NEW ROTATING COMMUTATOR [for Charging Condensers, etc.].—A. V. R. Telang. (Summary in *Review Scient. Instr.*, Dec., 1932, Vol. 3, p. 834.)

A NOVEL OPTICAL SCREEN FOR CLASSROOM DEMONSTRATIONS [White Cotton Threads stretched Vertically like Harp Strings].—J. H. Howey. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 777–781.)

FUSIBLE JACK FOR MULTI-RANGE METERS [each Jack containing the Appropriate "Littelfuse" and secured under the Binding Post of One Range].—(*Electronics*, Dec., 1932, p. 380.)

NEW DESIGN OF HIGH-WATTAGE INCANDESCENT LAMPS MADE POSSIBLE BY THE DEVELOPMENT OF A SIMPLE AND RELIABLE METHOD FOR MAKING A COPPER-TO-GLASS SEAL].—D. K. Wright. (*Review Scient. Instr.*, Jan., 1933, Vol. 4, No. 1, p. 38 : summary only.)

KEYBOARD TELEGRAPH TRANSMITTER AND RECORDER [for Unskilled Operators].—Painton and Paull, Ltd. (*Electrician*, 20th Jan., 1933, Vol. 110, No. 2851, p. 79.)

ON THE QUANTITATIVE THEORY OF THE WIMSHURST STATIC MACHINE : OF THE TOEPLER-HOLTZ STATIC MACHINE.—A. W. Simon. (*Review Scient. Instr.*, Feb., 1933, Vol. 4, pp. 67–74 : 75–82.)

STATIONS, DESIGN AND OPERATION

THE REQUIRED MINIMUM FREQUENCY SEPARATION BETWEEN CARRIER WAVES OF BROADCAST STATIONS.—P. P. Eckersley. (*Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 193–211.)

Author's summary :—"The general problem of interference between adjacent broadcast channels is discussed in relation to the average distribution of power over the frequency range of typical broadcast signals, the response characteristics of the ear, and the frequency characteristics of transmitters and receivers. The discussion includes a consideration of what may be accomplished by modifying the characteristics of transmitters and receivers, and the extent to which the required modifications depend upon relative field intensity of desired and interfering signals. The conclusions suggest that some rather extensive changes in the frequency allocation of broadcast channels will be necessary in order to provide at least one clear channel capable of high quality programme transmission to all receivers."

In Appendix I the writer describes the method employed to obtain the curve (Fig. 1A) showing the relative average energies in each part of the spectrum radiated by a broadcast station with different typical broadcast items. In Appendix II he describes an experiment regarding the ratio of wanted to unwanted carrier which must exist if "demodulation" effects are to be useful—a ratio as to which theoretical calculations have been made by other workers. The experimental results lead him to conclude that "the strength of the wanted station at the detector must be at least 10 db greater than the strength of the interfering station carrier at the detector if demodulation effects are to be sufficiently produced."

DRAHTGESTEUERTE SYNCHRONISIERUNG VON GLEICHWELLENSENDERN (Line-Controlled Synchronisation of Common-Wave Transmitters [using the Control only for Automatic Correction of Excessive Departure from Synchronism]).—W. Runge. (*Telefunken-Zeit.*, Dec., 1932, Vol. 13, No. 62, pp. 5–13.)

Synchronisation between several common-wave transmitters should if possible have a maximum error of 10^{-7}. With independent generators such accuracy is not practically possible. If synchronisation is carried out by low frequency over a cable, with subsequent frequency multiplication, errors occur which arise from irregular and variable phase rotations within the cable. Measurements of such rotations, carried out by the German P.O. in conjunction with the Telefunken Company, are given.

Instead of attempting to overcome such troubles by the use of synchronous motors with high momentum, or of lightly damped oscillatory systems (tuning-fork circuits with critical reaction), the writer proposes to abandon direct control, giving each transmitter its own generating circuits, rendered as constant as possible in frequency, and using the cable only for the automatic correction of frequency differences when these reach a predetermined maximum allowable value. Fig. 6 shows one version of his scheme, applied to two

stations, but this lends itself to further simplification by the replacement of the note-frequency tuning forks, and their associated frequency-multiplying circuits, by thermostatically controlled quartz oscillators with frequency-reducing circuits. These latter are not only simpler than frequency-multiplying circuits but also less influenced as to phase by variations in the working conditions. Each quartz oscillator controls the radio frequency of its transmitter, and also provides a note frequency. The note frequency is transmitted by the cable from the one station to the other, and is there automatically compared with the local note frequency by means of a phase-indicating instrument with relay contacts on either side of its zero. Thus when, and only when, the two transmitters get more than a certain amount out of synchronism, a correcting voltage is conveyed to the second transmitter which by suitable means corrects the frequency of the latter. Even a complete breakdown of the cable would not, with this system, interrupt the service; it would merely make it less perfect. Moreover, the transmitters are not interfered with by the small and rapid phase changes in the cable referred to earlier in this abstract.

PROJECTED ULTRA-SHORT-WAVE [" Microwave "] SERVICE FOR AIRCRAFT INFORMATION BETWEEN ENGLAND AND FRANCE. (*E.T.Z.*, 23rd Feb., 1933, Vol. 54, No. 8, p. 186.)

Paragraph on the projected service between stations near Hythe and Calais. In addition to being received aurally, the messages will be recorded for the sake of extra reliability. *See* also paragraph in *Electrical Communication*, January, 1933, Vol. 11, No. 3, p. 114, where it is mentioned that teleprinters will be used for transmitting and receiving.

MICRO RADIO WAVES—RECENT EXPERIMENTAL WORK CARRIED OUT IN ITALY—RECEPTION BEYOND OPTICAL RANGE.—G. Marconi. (*Electrician*, 6th Jan., 1933, Vol. 110, No. 2849, pp. 3–6.) *See* March Abstracts, pp. 153–154.

THE MARCONI SHORT-WAVE TELEPHONE-TELEGRAPH INSTALLATION OF THE LEAGUE OF NATIONS.—Marconi Company. (*Marconi Review*, Jan.–Feb., 1933, No. 40, pp. 13–26.)

THE NEW VIENNA BROADCASTING STATION.—Telefunken Company. (*Zeitschr. V.D.I.*, 25th Feb., 1933, Vol. 77, No. 8, p. 195.) *See* also April Abstracts, p. 215.

SYSTEM OF INTERFERENCE-FREE TELEGRAPHY.—Siemens and Halske: Jipp. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, No. 1, p. 36.) *See* Fig. 10.

SUPERVISORY AND CONTROL EQUIPMENT FOR AUDIO-FREQUENCY AMPLIFIERS.—H. Sohon. (*Proc. Inst. Rad. Eng.*, Feb., 1933, Vol. 21, pp. 228–237.)

Neither the r.m.s. voltmeter nor the average voltmeter, the two usual types of level indicators, shows how near the signal is to the overload point of the amplifier. A peak voltmeter (using two diodes and a triode) is here described which makes continuous measurements of the highest peak values reached by the signal: its principle is that a condenser is charged to the peak value of the voltage, and its charge leaks off slowly enough to allow an indication to be given by a galvanometer in the plate circuit of the triode.

The paper then describes an automatic control circuit which reduces the amplification of a special amplifier when the output voltage approaches a value which might overload succeeding apparatus. There is a lapse of time before the amplification returns to the previous value after the signal intensity decreases; this allows the hearers to know that there was a change in level.

GENERAL PHYSICAL ARTICLES

ON THE FLOW OF ELECTRIC CURRENT IN SEMI-INFINITE STRATIFIED MEDIA.—L. V. King. (*Proc. Roy. Soc.*, Feb., 1933, Vol. 139, No. A 838, pp. 237–277.)

The object of this paper is " to build up a theory of electrical conduction in stratified media which will enable the nature of the stratification to be deduced from measurements of surface potential gradients." Current is regarded as introduced at a theoretical point electrode at the free surface, and the steady state solution of the equation of continuity with appropriate boundary conditions is found by introducing an " electrical current function " ψ; an observable " surface gradient characteristic " is defined, which is the reciprocal of the " apparent resistivity " used by several writers. The " current function " and " gradient characteristic " are worked out for various stratifications, results of mathematical interest in connection with Sturm-Liouville expansions being obtained. The converse problem of the interpretation of some simple types of field graphs and the effect of frequency on surface potential distributions are also considered.

ON THE FOUNDATIONS OF THE ELECTRON WAVE EQUATION.—S. R. Milner. (*Proc. Roy. Soc.*, Feb., 1933, Vol. 139, No. A 838, pp. 349–368.)

Author's summary:—The properties of (1) classical action, (2) a wave field, in a four-dimensional manifold are analysed. The discussion results in a derivation from first principles of the differential equation of an arbitrary wave field. By applying it to the electron wave field it is found that Dirac's equation for ψ can be decomposed into two equations, determining respectively the amplitude and the phase of electron waves in a given electromagnetic field.

Consideration of the meaning of complex co-ordinates shows that the geometry of a manifold can be enlarged by their use in such a way that the quantum periodic properties of ψ, and the 16 generalised rotations discovered by Eddington, can be accounted for geometrically in a manifold of 4 dimensions only.

THE WAVE-MECHANICAL THEORY OF THE HARMONIC OSCILLATOR.—C. W. Oseen. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 3.) *See* also Gloden, *ibid.*, next abstract.

ELECTRICAL CHARGES SMALLER THAN THAT OF THE ELECTRON.—Ehrenhaft. (Summary in *Physik. Ber.*, 1st Jan., 1933, Vol. 14, No. 1, p. 47.)

A FURTHER POINT OF ANALOGY BETWEEN THE EQUATIONS OF THE QUANTUM THEORY AND MAXWELL'S EQUATIONS [leading to the Eddington Relation between Number of Electrons in the Universe and Its Radius].—M. Fahmy. (*Proc. Physical Soc.*, 1st Jan., 1933, Vol. 45, Part 1, No. 246, pp. 67–69.)

Continuing the work dealt with in Abstracts, 1931, pp. 339–340, and 1932, p. 478.

DEMONSTRATION OF THE EXISTENCE OF THE MULTIPLE COMPTON EFFECT.—H. Hulubei. (*Comptes Rendus*, 19th Dec., 1932, Vol. 195, No. 25, pp. 1249–1251.)

ARTIFICIAL PRODUCTION OF NEUTRONS.—C. C. Lauritsen, R. Crane and A. Soltan. (*Science*, 27th Jan., 1933, Vol. 77, No. 1987, Supp. p. 8.)

THE CHEMICAL NATURE OF THE NEUTRON.—P. Achalme. (*Comptes Rendus*, 27th Feb., 1933, Vol. 196, No. 9, pp. 614–616.)

A COMMON MISAPPREHENSION OF THE THEORY OF INDUCED MAGNETISM.—L. R. Wilberforce. (*Proc. Physical Soc.*, 1st Jan., 1933, Vol. 45, Part 1, No. 246, pp. 82–87.)

"It is usually stated that if any given magnet is immersed in a medium of permeability μ the magnetic field around it is similar to that in a vacuum, but diminished in strength in the ratio of $1 : \mu$. It is here shown that this statement is inconsistent with the ascertained experimental laws of induced magnetism."

ATOMIC MAGNETISM.—R. Chevallier: Cabrera. (*Rev. Gén. de l'Élec.*, 17th Dec., 1932, Vol. 32, No. 24, pp. 801–807.)

THE KINETICS OF ELECTRODE PROCESSES. PART II.—REVERSIBLE REDUCTION AND OXIDATION PROCESSES.—J. A. V. Butler and G. Armstrong. (*Proc. Roy. Soc.*, Feb., 1933, Vol. 139, No. A 838, pp. 406–416.)

A continuation of work referred to in 1932 Abstracts, p. 659.

ELEKTRISCHER BARKHAUSENEFFEKT AM SEIGNETTEKRISTALL (Electrical Barkhausen Effect in Crystals of Rochelle Salt).—M. Kluge and H. Schönfeld. (*Naturwiss.*, 3rd March, 1933, Vol. 21, No. 9, p. 194.)

THE ACTION OF A MAGNETIC FIELD ON THE ABSORPTION RAYS OF IODINE [and Its Destructive Action on Fluorescence].—I. I. Agarbiceanu. (*Comptes Rendus*, 13th March, 1933, Vol. 196, No. 11, pp. 760–762.)

THEORY OF THE CONDUCTIVITY OF POLARISABLE MEDIA. I AND II.—G. Jaffé. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, Nos. 2 and 3, pp. 217–248 and 249–284.)

INVESTIGATIONS ON THE "ELECTRICAL DIFFUSION" OF THE IONS IN GASES WITH UNIPOLAR CHARGE.—N. Wolodkewitsch. (*Ann. der Physik*, Feb., 1933, Series 5, Vol. 16, No. 4, pp. 431–467.)

ELECTRON BEAM AND GAS DISCHARGE.—Brüche. (*See* under "Subsidiary Apparatus and Materials.")

MISCELLANEOUS

THE METHOD OF COINCIDENCES, OR A QUICK METHOD OF DETERMINING THE APPROXIMATE VALUE OF A SIMPLE CORRELATION COEFFICIENT.—S. R. Savur. (Summary in *Physik. Ber.*, 15th Jan., 1933, Vol. 14, No. 2, pp. 105–106.)

THE CONCEPTS OF INVERSE PROBABILITY AND FIDUCIAL PROBABILITY REFERRING TO UNKNOWN PARAMETERS.—R. A. Fisher: Jeffreys. (*Proc. Roy. Soc.*, Feb., 1933, Vol. 139, No. A 838, pp. 343–348.)

A criticism of the paper by Jeffreys dealt with in January Abstracts, p. 55.

NOTES ON THE METHOD OF LEAST SQUARES.—A. S. Eddington. (*Proc. Physical Soc.*, 1st March, 1933, Vol. 45, Part 2, No. 247, pp. 271–287.)

A METHOD OF SOLVING ALGEBRAICAL EQUATIONS.—E. Lahaye. (*Comptes Rendus*, 13th March, 1933, Vol. 196, No. 11, pp. 742–744.)

THE JURIDICAL CONTROL OF RADIO IN FRANCE.—A. Mestre. (*Génie Civil*, 28th Jan., 1933, Vol. 102, No. 4, pp. 93–94.)

UTILISING THE RESULTS OF FUNDAMENTAL RESEARCH IN THE COMMUNICATION FIELD.—F. B. Jewett. (*Bell Tel. Quart.*, No. 2, Vol. 11, 1932, pp. 143–161.)

THE INTERNATIONAL INDEXING OF SCIENTIFIC AND TECHNICAL PAPERS.—S. C. Bradford. (*Engineering*, 3rd Feb., 1933, Vol. 135, No. 3499, pp. 119–122.)

REPORT ON THE PUBLICATIONS QUESTIONNAIRE SENT TO MEMBERS OF THE AMERICAN PHYSICAL SOCIETY [Economy Proposals: the Abstracts Problem]. (*Review Scient. Instr.*, Feb., 1933, Vol. 4, pp. 108–109.)

INTERNATIONAL INSTRUCTION IN COMMUNICATION.—F. Gill: Craemer, Ebeling and Küpfmüller. (*Elec. Communication*, Jan., 1933, Vol. 11, No. 3, pp. 155–158.)

Discussion by Gill (referring especially to telephony) of the German paper on "International courses of instruction for the Electrical Communication Service in connection with the C.C.I," an outline of which is given in an appendix.

THE PHYSICAL SOCIETY'S EXHIBITION. (*Engineering*, 10th Feb., 1933, Vol. 135, No. 3500, pp. 166–169.)

Continued from a previous issue. Among the

Marconi Company's exhibits here mentioned are :—micro-wave demonstration apparatus ; valve diathermy apparatus ; amplifying equipment giving "a flat response characteristic over the exceptionally wide frequency band from 10 cycles to 150 kilocycles per second and suitable for television purposes" (*see* under "Phototelegraphy and Television") ; apparatus for light-beam telephony (2 or 3 miles' range) ; portable apparatus for phototelegraphy over land line or wireless circuits ; and visual (equi-signal reed) course-indicators for aircraft.

Standard Telephones and Cables, Ltd., exhibited c.-r. oscillographs showing various developments (*e.g.*, provision for "viewing the fluorescent screen from the rear, as well as from the front, thus rendering the figures more clearly visible by the avoidance of reflections from the glass bulb") ; a high-quality m.c. microphone of which it is stated that "amplitude distortion is absolutely undetectable for all sound fields experienced in practice, and the speech to noise ratio is just over 15 db better than that of the high-sensitivity condenser microphone. Unlike the latter, it may be set up at a considerable distance from the associated amplifier, and because of its higher efficiency and lower impedance is less subject to interference from near-by circuits." The construction of this microphone is described.

Other items mentioned include coils wound on cores of "Gecalloy," composed of alloy particles insulated by chemical treatment and then subjected to a high pressure so that they cohere into a solid mass : the resistance to eddy currents is extremely high, while the remanence is equally low ; a logarithmic volume-indicator with a scale covering a range of about 30 db without appreciable departure from linearity (Muirhead, from a P.O. design) ; dynatron wavemeters and inductance-matching apparatus (Sullivan) ; and the "Visitron" photoelectric cells (*see* also under "Phototelegraphy and Television.").

THE PHYSICAL EXHIBITION. (*Electrician*, 6th Jan., 1933, Vol. 110, No. 2849, pp. 12–15.)

ELECTRICAL COMMUNICATION IN 1932.—I. T. and T. Laboratories, etc. (*Elec. Communication*, Jan., 1933, Vol. 11, No. 3, pp. 113–127.)

Among numerous items, a direct-reading d.f. is mentioned which "has the unique advantage of giving accurate bearings of a transmitter even if the signals are only of a few seconds' duration ; also, of obtaining accurate and continuous bearings between points in motion" (*e.g.*, during fleet manœuvres) : a special transmission cable for use between receiving aerial and short-wave receiving station : a "practically automatic" police radio system : micro-ray system for Air Ministry (*see* under "Stations, Design and Operation") : carrier telephony : teleprinters : and rediffusion and teleprogramme systems.

SIGNAL DISTORTION IN TELEGRAPH CIRCUITS.—E. H. Jolley. (*P.O. Elec. Eng. Journ.*, Jan., 1933, Vol. 25, Part 4, pp. 259–265.)

NEW USE FOR PHOTOCELL [preventing Damage to Printing Machinery if Paper Breakage occurs]. (*Wireless World*, 10th February, 1933, Vol. 32, p. 121.)

IMPROVEMENT OF THE PHOTOELECTRIC POLARIMETER.—G. Bruhat and A. Guinier. (*Comptes Rendus*, 13th March, 1933, Vol. 196, No. 11, pp. 762–764.)

The sensitivity of the polarimeter referred to in 1932 Abstracts, p. 660, has been increased so that a photoelectric current of 6×10^{-14} A causes a 5 mm deflection. A Philips electrometer valve is used whose grid resistance is of the order of 10^{14} ohms, with negative grid potential ; this allows the input resistance to be increased to 1.6×10^{10} ohms.

APPLICATIONS OF PHOTOELECTRIC CELLS IN CHEMICAL ENGINEERING.—C. J. Smithells. (*Chemistry and Industry*, No. 21, Vol. 51, 1932, pp. 446–451.)

A PHOTOELECTRIC METHOD OF PUTTING IN EVIDENCE THE MITOGENETIC RADIATION OF GURWITSCH.—L. Petri : Gurwitsch. (*Lincei Rendic.*, No. 12, Vol. 15, 1932, pp. 919–925.)

For papers on this radiation *see* Abstracts, 1931, p. 632 (Glasser and Seitz) and 286 (Tokin : Stempell); 1932, p. 301 (Magrou and Reiss).

STRINGENT TEST FOR PHOTOELECTRIC CELL [Half-Mile Optical Link in Broadcast Transmission]. (*See* under "Transmission.")

THE PIEZOELECTRIC MEASUREMENT OF MECHANICAL VIBRATIONS, ACCELERATIONS AND EXTENSIONS.—J. Kluge and H. E. Linckh. (*E.T.Z.*, 16th Feb., 1933, Vol. 54, No. 7, pp. 158–159.)

MEASUREMENT OF THE VIBRATIONS OF RAILWAY SUPERSTRUCTURES.—H. W. Koch. (Summary in *Physik. Ber.*, 1st Feb., 1933, Vol. 14, No. 3, pp. 177–178.)

GERMAN STATE RAILWAYS' APPARATUS FOR THE CALIBRATION OF MEASURING INSTRUMENTS FOR THE DETERMINING OF MECHANICAL MOVEMENTS.—R. Bernhard and A. Kammerer. (*E.T.Z.*, 16th March, 1933, Vol. 54, No. 11, pp. 257–260.)

MAGNETIC APPARATUS FOR THE MEASUREMENT OF THICKNESSES [*e.g.* of Thin Sheets or Wires of Non-Magnetic Materials : Direct-Reading, suitable for Continuous Operation].—P. Bricout. (*Comptes Rendus*, 6th March, 1933, Vol. 196, No. 10, pp. 689–691.)

NIKOLA TESLA AND HIS WORK. (Book Review in *Hochf:tech. u. Elek:akus.*, Feb., 1933, Vol. 41, pp. 41–43.)

RADIO ENGINEERING.—F. E. Terman. (Book Review in *Electronics*, Feb., 1933, p. 42.)

Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

RECHARGING H.T. BATTERIES

Application date, 15th April, 1932. No. 381107

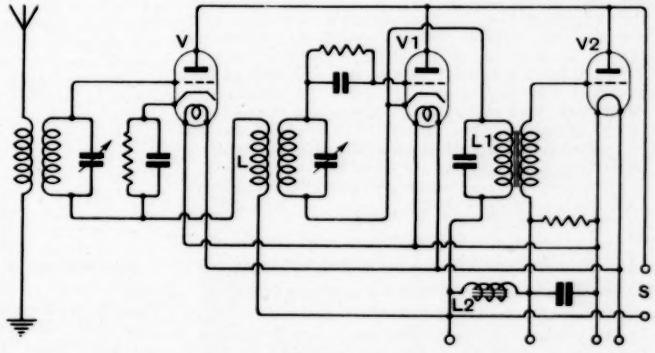
A high-tension battery of the wet-cell type is "freshened" periodically from a low-tension accumulator by connecting the latter across different sections of the H.T. unit, in succession, during such time as the receiver is out of use. This is done, without disconnecting either of the batteries from the set, by means of a multipole switch having a rotating arm adapted to be moved forward manually, from stud to stud, at suitable intervals.

Patent issued to J. Wood.

CATHODE-COUPLED AMPLIFIERS

Application date 23rd July, 1931. No. 382307

A multivalve set is characterised by the feature that one or more of the intervalve couplings is located on the cathode side of the common high-tension supply, instead of being situated, as usual, between the anode and the positive pole of the H.T. As shown in the figure, each of the valves *V*, *V1* is coupled to the next stage through primary windings *L*, *L1* inserted on the negative side of the common H.T. supply *S*. The coil *L2* is similarly located in the plate circuit of the output valve *V2*. A push-pull arrangement employing the same type of coupling is also described, together with a scheme for automatically balancing-out any grid current, so that amplification may extend over a voltage swing which throws the grid from negative to positive without introducing distortion.



No. 382307

Patent issued to Igranic Electric Co., Ltd., and L. H. Paddle.

SHORT-WAVE TELEVISION

Convention date (Germany), 17th November, 1930. No. 381750

The picture, scanning-control frequencies, and sound signals are all superposed on a common ultra-short carrier-wave. At the receiving end the various signals are separated out and applied, so far as the picture and synchronising frequency are concerned, to a cathode-ray tube of the type in which the varying light-and-shade effects are controlled by a Wehnelt cylinder surrounding the cathode of the tube. The anode voltage for the cathode-ray tube is also used to energise high-mu amplifying stages both for the picture signals and the synchronising frequencies. The sound signals may be duplicated in order to secure a binaural effect.

Patent issued to M. von Ardenne.

L.F. TRANSFORMERS

Application date, 26th June, 1931. No. 381540

A transformer is designed to allow the response curve to be "tilted" up or down, according to the particular circuit, *e.g.*, pick-up, microphone, or valve amplifier, to which the transformer is coupled. This object is secured by dividing the secondary windings into two or more sections and imparting to each a desired or compensating characteristic by means of auxiliary resistances and capacities inserted in series and shunt across one or more of the sections.

Patent issued to J. Poliakoff.

HIGH-EMISSION CATHODES

Convention date (Germany), 31st May, 1930. No. 379702

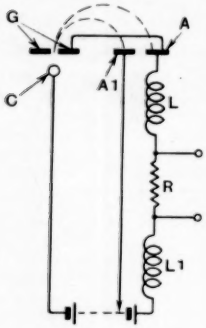
Tungsten or nickel-chromium wire is fed slowly through a potassium hydroxide melt so that it is evenly coated to a thickness determined by the speed of travel. The coated wire is next inserted as a cathode in a valve, which is sealed and exhausted. Metallic barium is then vaporised in the valve, and the vapour is deposited on the prepared alkali coating without the formation of blended or compound oxides of varying conductivity.

Patent issued to Radio A-G. G. S. Loewe.

GENERATING H.F. OSCILLATIONS

Application date, 28th July, 1931. No. 382638

Frequencies corresponding to wavelengths varying from 20 or 30 centimetres up to 5 or 6 metres are generated by shifting the stream of electrons from a cathode "gun," under the control of an external electric or magnetic field, from one to another of two anodes at a speed corresponding to the wavelength required. As shown in the figure, the emission from the cathode *C* passes through a "split" control electrode *G* on to a double anode *A*, *A*1. The initial adjustments of voltage and control field are such that the stream takes the dotted-line curved path on to the anode *A*, which is connected through coils *L*, *L*1 and a resistance *R* to positive H.T. The resulting current through the external circuit produces a fall in the potential between the split grid *G* and the cathode, which results in a relative drop in the velocity of the electron stream so that it is now diverted on to the second anode *A*1, which is tapped to a point on the H.T. supply as shown. This produces a relative rise in the potential of the anode *A* and of the grid system *G* to which it is connected, and causes a corresponding swing-back of the stream to that anode. The cycle of events is repeated indefinitely, the resulting high-frequency variations being tapped off from the resistance *R*.



No. 382638

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and G. F. Brett.

SUPER-REGENERATIVE RECEIVERS

Convention date (Germany), 23rd June, 1931. No. 381902

The quenching oscillations for a super-regenerative circuit are derived from a glow-discharge tube, such as a Neon lamp, connected either to a separate voltage supply or to the anode of the valve amplifier. The Neon lamp discharges periodically as the oscillation voltages build up, and forms a "spill over" circuit which periodically controls the amplifying action of the main valve in the well-known manner.

Patent issued to Telefunken Ges. fur drahtlose Telegraphie m.b.h.

AMPLIFYING CIRCUITS

Convention date (U.S.A.), 21st July, 1930. No. 381539

A receiving set is designed to ensure constant amplification and also constant selectivity over the normal broadcast band. The input is made inherently resonant at a frequency slightly below the lowest broadcast frequency, and is coupled to the secondary circuit through a mixed capacity and magnetic coupling, as are the subsequent intervalve circuits. An auxiliary coil coupling offsets the normal inductive loss in the secondary circuit due to the proximity of the aerial inductance. Volume control is secured through one resistance shunted across the aperiodic aerial and another across the aperiodic input to a subsequent H F stage. A low-pass filter cuts out any H.F. components in the output circuit from the detector valve. Tone-compensation is provided in the L.F. circuits. A detailed description is given of a receiver with ganged tuning-control comprising 2 H.F.—Det—3 L.F. and tone-compensating stages, followed by a push-pull output.

Patent issued to Hazeltine Corporation.

NO-FILAMENT VALVES

Convention date (Germany), 27th January, 1931. No. 381432

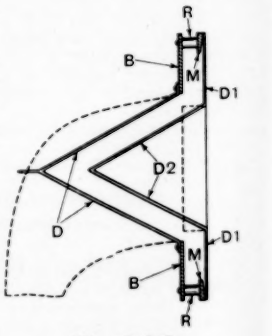
Relates to valve amplifiers of the kind in which the source of the normal electron stream is a glow discharge set up between two auxiliary electrodes, which take the place of the usual filament or cathode. The invention consists in forming the auxiliary strip electrodes as a unitary structure separated by a strip of mica and arranged around the control grid, which is concentric with the anode. The glow discharge occurs on the free surface of the cathodic strip, and the discharge is forced to take a more or less roundabout path into the main amplifying space of the gas-filled tube so as to ensure a copious liberation of secondary electrons which augment the effective output from the amplifier.

Patent issued to Telefunken Ges. fur drahtlose Telegraphie m.b.h.

LOUD SPEAKERS

Application date, 2nd April, 1932. No. 382868

A second or auxiliary diaphragm *D*1, with a conical depression *D*2, is located in front of the ordinary cone or diaphragm *D* and baffle-board *B* so as to emphasise the effect of high-frequency notes by increasing the area on which they react, and thus ensure a better balance between high notes and low. The auxiliary diaphragm is mounted on a frame *M* attached at intervals to the baffle-board by means of screws and rubber distance-pieces *R*, so as to leave a free air-passage between the two diaphragms.



No. 382868

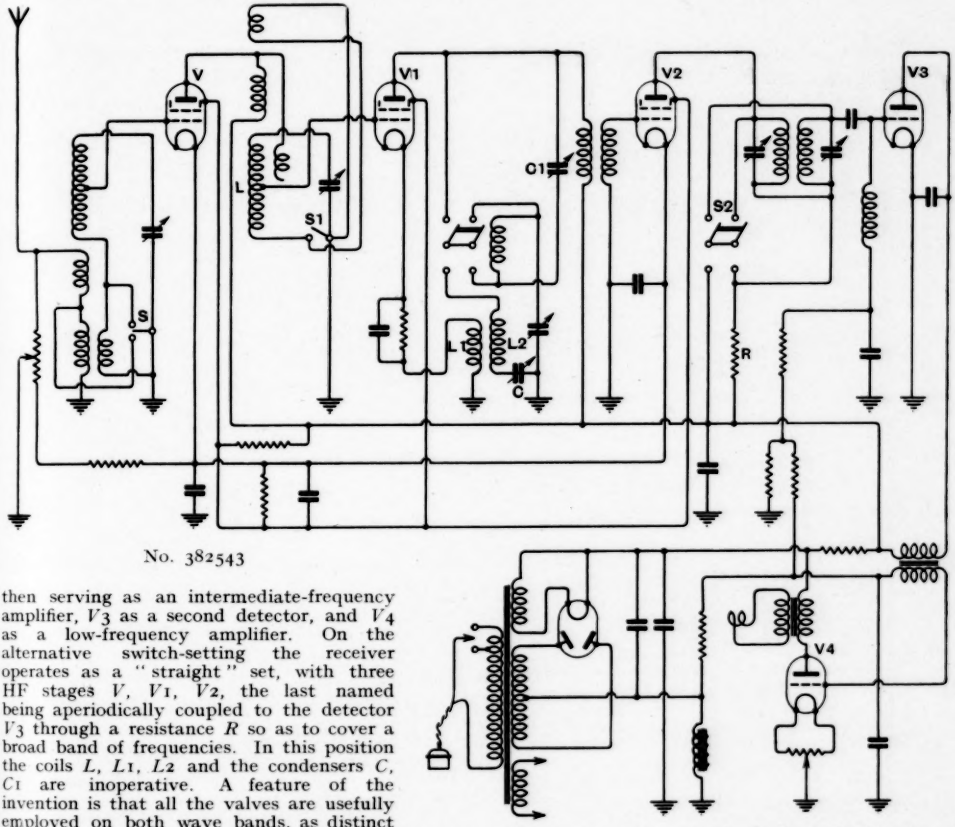
Patent issued to S. J. Murdoch.

WIRELESS RECEIVERS

Application date, 7th April, 1932. *No.* 382543

The circuits are so arranged that in one position of the ganged switches *S*, *S1*, *S2* the valve *V1* operates as a combined detector-oscillator for the supersonic reception of short waves, the valve *V2* then serving as an intermediate-frequency amplifier, *V3* as a second detector, and *V4* as a low-frequency amplifier. On the alternative switch-setting the receiver operates as a "straight" set, with three HF stages *V*, *V1*, *V2*, the last named being aperiodically coupled to the detector *V3* through a resistance *R* so as to cover a broad band of frequencies. In this position the coils *L*, *L1*, *L2* and the condensers *C*, *C1* are inoperative. A feature of the invention is that all the valves are usefully employed on both wave bands, as distinct from arrangements in which the first detector is cut out for "straight" reception.

Patent issued to H. F. Schwarz.



No. 382543

SUPERHETERODYNE RECEIVERS

Convention date (Belgium), 25th June, 1931. *No.* 381907

It is desirable to insert between the intermediate-frequency stages of a superhet circuit a band-pass coupling, comprising a series combination of inductance and capacity tuned to the mean frequency of the wave-band to be passed. The difficulty, however, arises that to match the valve impedance a high-inductance output transformer must be used, which necessitates a high value of series inductance, and this, in turn, makes the series capacity impracticably small. According to the invention the problem is solved by inserting the series-tuned band-pass combination between a step-down output transformer from the first I. F. valve and a step-up input transformer to the next valve.

Patent issued to N. V. Philips Gloeilampenfabrieken.

Application date, 16th October, 1931. *No.* 382057.

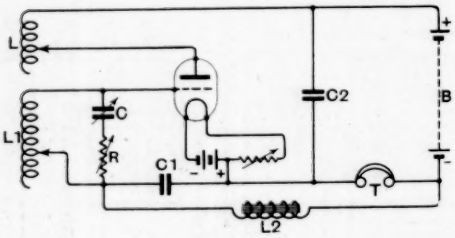
In order to improve overall amplification in the input stage of a superheterodyne receiver the output from the first screened-grid valve is taken direct to the grid of the oscillator, and a high impedance (*e.g.*, a small condenser) is inserted in the grid circuit of the latter valve to prevent any leakage of the signal energy through to the cathode. A circuit tuned to the signal frequency may take the place of the blocking condenser. Preferably a screened grid or pentode valve is used as the local oscillator.

Patent issued to O. Wullenweber.

"MIDGET" RECEIVERS

Convention date (U.S.A.), 24th April, 1931.
No. 382881

A receiver of the super-regenerative type is characterised primarily by a simple and compact



No. 382881

construction, capable of being completely housed in an ordinary cigar box and weighing less than two pounds. A single valve (U.S.A. classification UX 230) is used with 3 volts across the filament and 4½ volts on the plate. The tapped plate-coil *L* is back-coupled to a tapped grid-coil *L1*, the latter being shunted by a variable condenser *C* in series with a variable resistance *R*. The "quenching" circuit comprises a choke *L2*, the condensers *C1*, *C2*, and the battery *B*, with a pair of headphones *T* in shunt.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

THERMIONIC AMPLIFIERS

Convention date (U.S.A.), 5th June, 1931.
No. 382579

In a mains-driven receiver with the heaters for the valves arranged in series across the supply, and with "free" grid bias, undesirable feed-back is prevented by connecting a high-impedance element between each cathode and its corresponding heating-element, and a low-impedance element between each cathode and ground. This by-passes any fluctuating potentials on the cathode to ground, away from the heater and its leads. A path of relatively low resistance to unidirectional current is also connected between each grid and ground, thus serving to maintain a constant operating-potential between grid and cathode.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

H.F. TRANSMISSION LINES

Convention date (U.S.A.), 22nd December, 1930.
No. 382461

In order to prevent radiation from the supply lines feeding high-frequency currents to a transmitting aerial, particularly in respect of currents of harmonic frequency which tend to flow in parallel over both feed-wires, a third conductor is inserted in close proximity to the two main feeders. This additional line is connected to the mid-point of the output transformer so that it carries current of the undesired frequency in the opposite direction to its flow along the main feeders. The third line is earthed at a number of points along its length.

Patent issued to British Thomson-Houston Co., Ltd.

AUTOMATIC VOLUME CONTROL

Convention date (U.S.A.), 15th April, 1931.
No. 381868

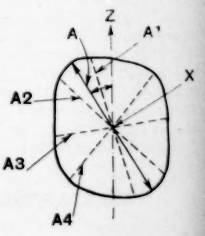
In receiving sets provided with a special control valve for automatically regulating signal strength, the control valve is normally arranged to adjust the input stages for maximum sensitivity during such time as no carrier wave is being received. This in turn tends to accentuate the general background of noise due to static and fortuitous interference at intermediate points on the tuning dial. According to the invention an auxiliary valve is provided to attenuate the higher audio-frequency noises during "idle" periods, and thus minimise the more unpleasant part of the disturbance. The grid of the auxiliary valve is biased by the control valve, whilst its output circuit, which comprises a choke coil in parallel with a condenser, is shunted across the output of the detector. The result is that as the automatic volume control increases the sensitivity of the H.F. stages it also increases the by-passing effect of the auxiliary valve on the high-note "noise," and so diverts the latter from the loud-speaker.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

PIEZO-ELECTRIC OSCILLATORS

Convention date (Germany), 2nd December, 1930.
No. 383075

Because the modulus of elasticity is different along the different radii of a disc-shaped piezo-crystal it is difficult to ensure stable operation at constant frequency. The frequencies are, in fact, directly proportional to the square roots of the moduli of elasticity and inversely proportional to the diameter lengths. To ensure stability the contour of the crystal is accordingly made such that the various diameters *A*, *A1*, etc., measured from their intersection on the optical axis *X* are symmetrical about that axis, and have a length proportional to the square root of the modulus of elasticity in each particular direction. The thickness is such that the oscillation frequency in the radial direction is equal to the thickness vibration or to an harmonic thereof. The optical axis is shown at *Z*.



No. 383075

Patent issued to H. Straubel.